



THE SECRETARY OF THE INTERIOR

WASHINGTON

December 26, 1962

Dear John:

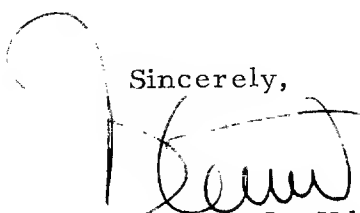
**On file DOI release instructions apply.**

Attached you will find an advance copy of the report I and my colleagues prepared on our trip to the Soviet Union last September. There are some items in the report which undoubtedly will be of interest to your people--and I dare say you will personally want to peruse the summary statement which appears at page 94. On pages 105 and 106 I made special mention of Minister (now Deputy Premier) Novikov. In my opinion he is a "comer", and it was he who I had in mind during the remarks I made at the White House discussion group a couple of weeks ago. It is likely that he will head a Soviet exchange delegation which will inspect some of our installations next summer.

If I can be of further assistance to you and your associates, please call on me at any time.

Best personal regards.

Sincerely,

  
Stewart L. Udall  
Secretary of the Interior

The Honorable  
John A. McCone  
Director of Central Intelligence  
2430 E Street, N. W.  
Washington, D. C.

MEMORANDUM FOR: DCI  
DDCI

Copy of report also sent to Executive Director with note of thanks to him from Secretary Udall for CIA's help in preparing report. Kirkpatrick will send his report to ORR for their use.



LBKirkpatrick

**GIA HISTORICAL REVIEW PROGRAM**  
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CENTRAL INTELLIGENCE AGENCY

OFFICE OF THE DIRECTOR

4 January 1963

Mr. Kirkpatrick

DCI has noted. He requests DDI to bring any interesting items to his attention.



STAT

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## NOTE

### THIS IS AN ADVANCE COPY

The material it contains is not to be released until after a press conference to be held at <sup>3</sup>~~2~~:00 p.m. December 27, 1962, by Secretary Udall.

# **RECENT ELECTRIC POWER DEVELOPMENTS IN THE U.S.S.R.**

REPORT OF THE  
UNITED STATES DELEGATION  
TOUR TO SOVIET RUSSIA,  
AUGUST 28-SEPTEMBER 9, 1962,  
UNDER U. S. - U. S. S. R.  
EXCHANGE AGREEMENT

RECENT ELECTRIC POWER DEVELOPMENTS IN THE U.S.S.R.

Report of the  
United States Delegation Tour to Soviet Russia  
August 28-September 9, 1962  
Under U.S.-U.S.S.R. Exchange Agreement\*

December 27, 1962

\* Component parts of the report were prepared by various members of the group. The report is a composite of the several impressions received by individual members.

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## INTRODUCTION

Prior to 1962 there were three official visits by electric power delegations from the United States -- two by representatives of the private utility companies in the summers of 1958 and 1959, under auspices of the Edison Electric Institute, and another by representatives of the Senate Committees on Public Works and Interior and Insular Affairs, under the chairmanship of Senator Frank E. Moss of Utah. The present group, rounding out the compass of interest, consisted of public officials responsible for the administration of power policy in the United States.

### Delegation Membership

The delegation was headed by the Secretary of the Interior, who is responsible for the operations of the Bureau of Reclamation, Bonneville Power Administration, Southeastern Power Administration, and Southwestern Power Administration. The Bureau of Reclamation is one of the two largest builders of hydroelectric powerplants in the United States, while the other agencies in the Department are the marketing bureaus for power developed by the Government. The Bonneville Power Administration is the marketing agent in the Pacific Northwest and one of the country's largest builders of transmission lines.

Among the other members of the delegation were Joseph C. Swidler, Chairman of the Federal Power Commission, Major General R. G. MacDonnell of the Corps of Engineers, and Fred Chambers, Assistant Director of the Tennessee Valley Authority. The Corps of Engineers



The delegation departing from Friendship Airport: 1. Secretary of the Interior, Udall, 2. James K. Carr, 3. Joseph G. Scidler, 4. Howard Morgan, 5. Leo G. White, 6. Orren Beatty, 7. Floyd E. Donny, 8. Charles E. Luce, 9. Maj. Gen. R. G. MacDonell, 10. T. W. MacDonell, 11. Fred Chambers, 12. Curtis W. Kamrion. Consultants: 13. Paul F. Shaad, 14. James F. McNulty.

Also in a separate Exchange program departing at the same time were: 15. Robert Frost, 16. Frederick Adams, 17. Franklin C. Reeves.

is the other major dam and hydroplant construction agency. The Tennessee Valley Authority, an independent Government agency, has constructed many dams and hydroelectric and thermal powerplants, including accessory high-voltage transmission lines. The TVA is almost the sole supplier of electric power in an area of about 80,000 square miles; it is the largest single purchaser and consumer of coal in the United States. The Federal Power Commission licenses the development of hydroelectric projects and regulates the operation of power companies.

The delegation included:

Stewart L. Udall	Secretary of the Interior, Chairman of the delegation
James K. Carr	Under Secretary of the Interior
Joseph C. Swidler	Chairman of the Federal Power Commission
Howard Morgan	Commissioner, Federal Power Commission
Lee C. White	Assistant Special Counsel to the President
Orren Beaty, Jr.	Assistant to the Secretary of the Interior
Floyd E. Dominy	Commissioner, Bureau of Reclamation
Charles F. Luce	Administrator, Bonneville Power Administration
Maj. Gen. R. G. MacDonnell	Director of Civil Works, Corps of Engineers, Department of the Army
T. W. Mermel	Chief, Division of General Engineering, Bureau of Reclamation

**Fred Chambers**

**Assistant Director of Power  
Planning and Engineering,  
Tennessee Valley Authority**

**Curtis W. Kamman**

**Interpreter,  
Department of State**

**Consultants**

**Paul E. Shaad**

**Special Consultant to the  
Secretary of the Interior  
(General Manager and Chief  
Engineer of Sacramento  
Municipal Utilities District)**

**James F. McNulty**

**Special Consultant to the  
Secretary of the Interior  
(Attorney for Sulphur Springs  
Valley Rural Electric Co-op,  
Bisbee, Arizona)**

**Russian Hosts**

The United States delegation left by plane on August 28, 1962, and arrived at Moscow airport August 29. It was greeted at Moscow airport by a group of officials holding various high responsibilities in Soviet power development. These included K. D. Lavrenenko, Deputy Minister of the Ministry of Power Station Construction; M. M. Chuprakov, Chief Design Engineer of the Ministry of Power Station Construction; N. P. Galochkin, Chief Engineer of Export; A. I. Krollov, Consulting Engineer; Denis N. Polakov, Deputy Chief, Division of the Foreign Relations Department and member of the State Committee for Coordination of Scientific Research; and A. U. Bochever, Protocol Officer of the Department of Foreign Relations.

On August 30, the United States party was welcomed by Deputy Minister of Power Station Construction, Pjotr S. Neporozhny, in his

office. Mr. Neporozhny was in charge of the Ministry in the absence of Minister I. T. Novikov. About 20 members of his technical staff were present. Mr. Neporozhny briefly outlined the itinerary and explained in general terms what would be seen. He gave each of the party a packet of technical literature describing the projects to be visited, including a book in Russian titled "Large Dams in the U.S.S.R." This describes and illustrates some 55 major dam structures. The book now is being translated in the United States for public distribution. The projects selected were those the visiting delegation had expressly wished to see. Of extreme benefit to the United States group in its travels was a detailed presentation by Mr. Chuprakov on power developments in the U.S.S.R. and the Soviet plans regarding them.

The delegates were assured there would be no restriction on photography, with the exception of photographs at airports or from aircraft.

Deputy Minister Neporozhny assigned Messrs. Chuprakov, Polakov, and Bochever, and a woman interpreter to the visitors on the journey.

#### Purpose of Visit

The primary interest of the delegation was in the more recent large dams and hydroelectric plants in operation, or under construction, in the Soviet Union--and the extra high voltage (EHV) transmission lines built to carry the power the long distances to load centers. The highest voltage now generally used in the United States is 345,000, with the single exception of a 13-mile segment of one

line operating at 500,000 volts. (The 500,000-volt line of the Virginia Electric Power Company from the coal fields of West Virginia to Washington, D. C., and Richmond, Virginia, will be completed in 1965. Several other EHV facilities have been constructed for test purposes at 500,000-750,000 volts.) An 800,000-volt direct-current line (400-kv.+), based on successful operation of experimental lines, was reported under construction in the U.S.S.R.

The United States group sought firsthand information about the engineering techniques used by the Soviets. This is particularly important because the United States, under the Federal Power Commission, is conducting a National Power Survey, the results of which will be of great significance in determining future national goals.

Because of the pioneering work in Sweden and England in the direct-current technique of moving large blocks of power, part of the United States delegation also visited these two countries to observe installations and to discuss technologic problems and advancements. The Sweden-England tour, made by a six-member group following completion of the Russian itinerary, was under the direction of Under Secretary of the Interior James A. Carr.

#### Travel Arrangements

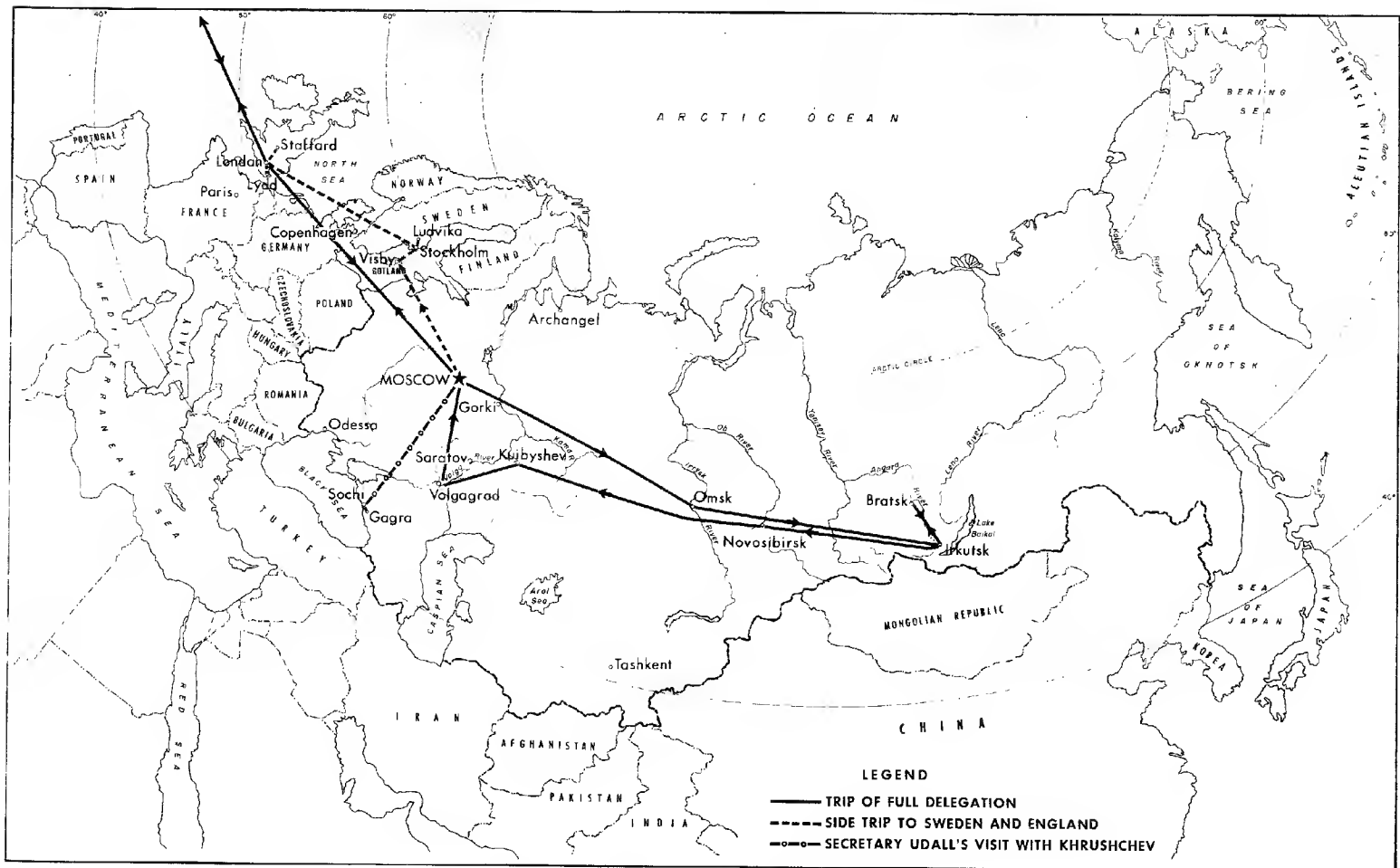
Travel to Moscow and return was by commercial airlines, as was travel in the U.S.S.R. itself, except that chartered planes were used when commercial flights were not scheduled to points the party was to visit.

#### Itinerary

The tour covered 11 days, during which the delegation visited, among other places, the Irkutsk hydroelectric plant, the mammoth

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ITINERARY - AUGUST 28 - SEPTEMBER 9, 1962

Figure 2

new hydroelectric project being built at Bratsk, and the completed stations at Kuibyshev and Volgograd. The itinerary follows:

August 28, 1962	Left United States.
August 29, 1962	Arrived at Moscow.
August 30, 1962	Morning--Met Ministry of Electric Power Station Construction.  Afternoon--Discussion at the Office of the State Committee of the Council of Ministers in the U.S.S.R. for Coordination of Scientific Research.  Evening--Departure for Irkutsk, Siberia.
August 31, 1962	Irkutsk hydroelectric power station.
September 1, 1962	Bratsk hydroelectric project, having an ultimate 4,500,000-kilowatt capacity. Now in partial operation including associated 500-kv. transmission facilities.
September 2, 1962	Lake Baikal area.  Evening--Departed for Kuibyshev.
September 3, 1962	Kuibyshev hydroelectric power station, having a 2,300,000-kilowatt capacity for furnishing power at 500-kv. to Moscow and the Ural area
September 4, 1962	Departed for Volgograd. Enroute saw Saratov Dam under construction from air. Visited Volgograd hydroelectric power station, 2,560,000-kilowatt capacity and furnishing power at 500-kv. to Moscow. Visited also 800-kv. d-c installation
September 5, 1962	Morning--Departed for Moscow.  Afternoon--Direct-Current Institute and terminal of the Kashira-Moscow 200-kv. d-c line.

September 6, 1962      500-kv. Chaguinskai substation (Moscow suburb)  
  
V. I. Lenin All-Union Electrotechnical Institute.  
  
Secretary Udall meets Premier Khrushchev at Premier's estate on Cape Pitsunda (near Sochi) on Black Sea.

September 7, 1962      Dispatching center of European power system of the U.S.S.R.  
  
Concluding discussion at the office of the Ministry of Electric Power Stations.

September 8, 1962      Main party left Moscow.

September 9, 1962      Arrived in Washington.

The United States group traveled about 17,450 air-miles, of which 7,450 miles were in the U.S.S.R.

From	To	Approximate Air-Miles
Washington, D. C.	Moscow	5,000
Moscow	Irkutsk	3,200
Irkutsk	Bratsk	275
Bratsk	Irkutsk	275
Irkutsk	Kuibyshev	2,700
Kuibyshev	Volgograd	430
Volgograd	Moscow	570
Moscow	Washington, D. C.	5,000
Total		17,450

The itinerary for the trip to Sweden and England, under the chairmanship of Under Secretary James K. Carr, was:

September 8, 1962	Left Moscow, arriving at Visby, Gotland Island, Sweden. Inspected direct-current terminal facilities for connecting island with Swedish mainland.
September 9, 1962	High-voltage direct-current research centers and manufacturing facilities of Allmanne Svenska Elektriska Aktiebolag at Ludvika, Sweden.
September 10, 1962	Left Sweden, arriving at Lydd, England. Visited direct-current terminal facilities used for the English Channel crossing.
September 11, 1962	Direct-current research and manufacturing facilities of English Electric Company at Stafford.
September 12, 1962	Departed for United States.

## PART I. RUSSIAN INSTALLATIONS VISITED

A subsequent section in this report lists the 20 largest earth dams in the world and the 20 largest hydroelectric plants, as well as the largest reservoirs. Seven of these hydroelectric plants and eight of the dams are in the Soviet Union. Bratsk, Volgograd, and Kuibyshev are among the largest hydroplants and the largest reservoirs; Kuibyshev and Volgograd among the largest dams. It was for this reason that the United States group had requested that these works be included in the itinerary. The Bratsk plant, when completed, will be the world's second largest; and when the reservoir behind the dam is full, it will hold nearly five times as much water as Lake Mead behind Hoover Dam in the United States.

In the construction of the huge Soviet projects, the Soviet engineers not only have exploited effectively the techniques utilized in the building of similar dams elsewhere in the world, they also have used different and unusual methods to solve the peculiar engineering problems they confronted.

Highlights of what the United States group witnessed at those three places and at Irkutsk and at the Chaguinskai substation near Moscow--together with a brief note on the trip to Sweden and England--are given in the following pages. The data and impressions gathered at the other places visited--the Direct-Current Institute, the Lenin Electrotechnical Institute, the dispatching center, and the terminal

of the Kashira-Moscow d-c line, all in Moscow--are described in the chapter on Soviet technology.

### Irkutsk

The Irkutsk dam and powerplant, completed in 1956, is in Siberia, 3,200 miles east of Moscow on the Angara River as it leaves Lake Baikal. The Angara River is the second largest river in Siberia, having an annual flow of about 73 million acre-feet.

The Irkutsk dam is an earth-fill structure, 8,989 feet long, 172 feet high, and 985 feet wide at the base, and contains 16,218,000 cubic yards of fill. The crest is 52 feet wide. The powerplant, which occupies 955 feet along the dam, is an integral part of the dam.

The clay core was placed in the summer, but the rest of the work continued regardless of season, some of it during freezing weather. The only compaction of the fill was that provided by the loaded 25-ton dump trucks traveling over it. A large free-board protects against the high waves from the lake, sometimes eight feet high, and the dam is faced with sheet metal to protect against erosion. The draft tubes are screened against the entry of ice; and although electrical heating units are installed on the screens, they are not used, the hot air from the generators being diverted for this purpose.

The powerplant contains eight turbines rated at 82,500 kilowatts each, for a total generating capacity of 660,000 kilowatts.

An unusual feature is the absence of an overflow spillway. Since the dam controls the level of water in Lake Baikal, the discharge of the Angara River is almost uniform throughout the year. To permit bypassing water around the powerhouse, 16 discharge sluices are incorporated in the powerhouse structure between the generating units. This feature has since been used in other dams on the Volga River.

Bratsk

Bratsk Dam also is on the Angara River, 275 miles north of Lake Baikal. Work began in 1955 and is expected to end in 1965. When completed, the dam will back up a reservoir having a capacity of 145 million acre-feet and covering 1,935 square miles. The dam will be 410 feet high and contain 22 million cubic yards of earth. Some 6-1/2 million cubic yards of concrete will be placed, reinforced by 400,000 tons of metal.

The hydroelectric plant will have 20 units of 225,000 kilowatts each, for a combined capacity of 4,500,000 kilowatts, and is expected to operate about 60 percent of the time to yield an annual output of 22 billion to 25 billion kilowatt-hours.

Total capital investment, including dam and powerplant, roads, housing and resettlement of population, will be approximately \$720 million (U. S. equivalent), and the annual budget is projected at \$122 million. Cost per kilowatt-hour will be \$0.0036. In this estimate, amortization of the dam is figured over 25 years, as against the usual 100 years in

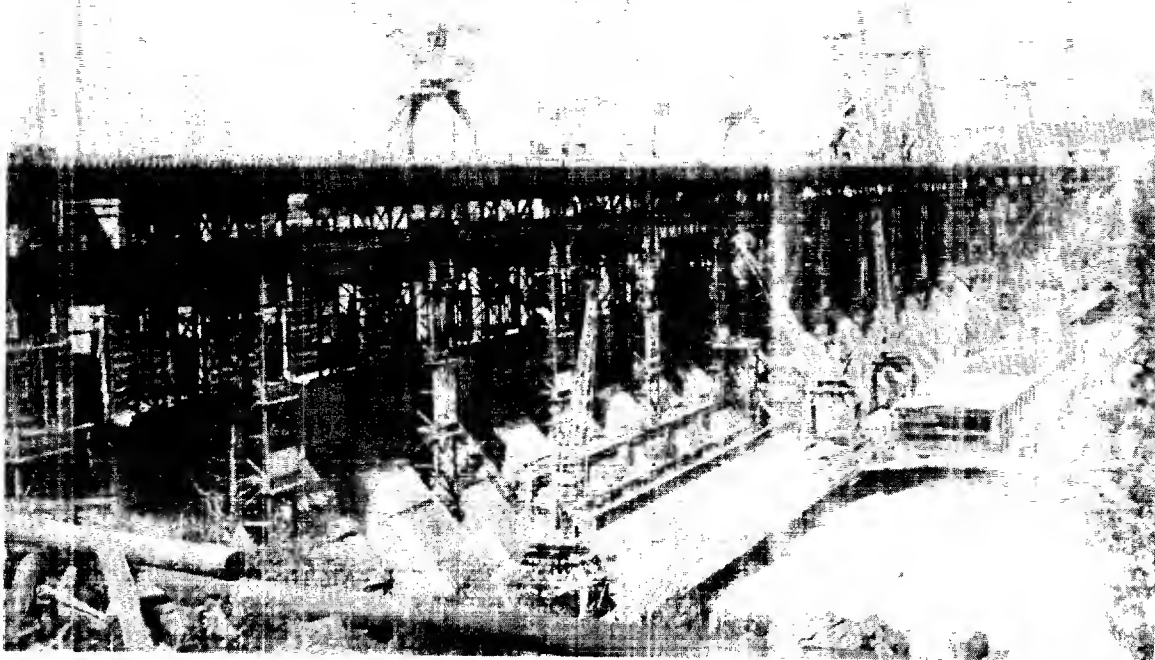


Figure 3 - Bratsk Dam in summer 1962. The hammerhead cranes reach out 164 feet and are capable of lifting 24 tons

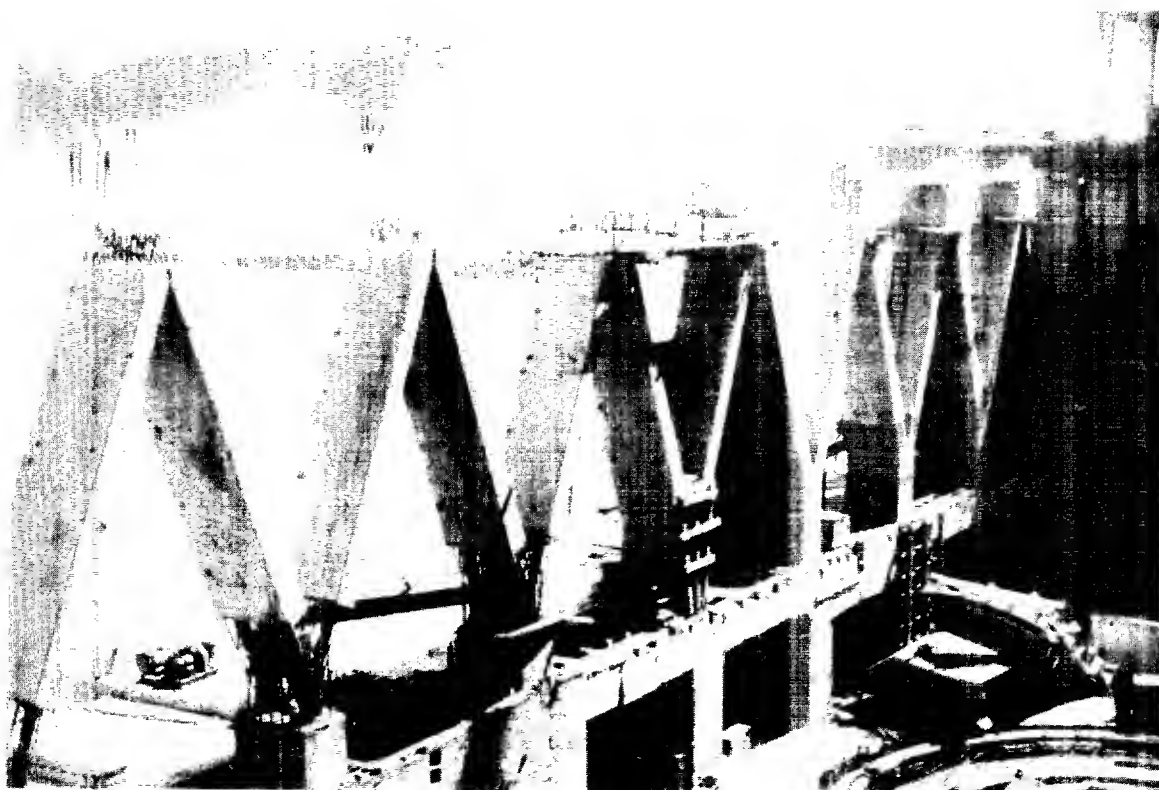


Figure 4 - Precast concrete column at Bratsk





Figure 5 - Downstream portion of Bratsk Dam

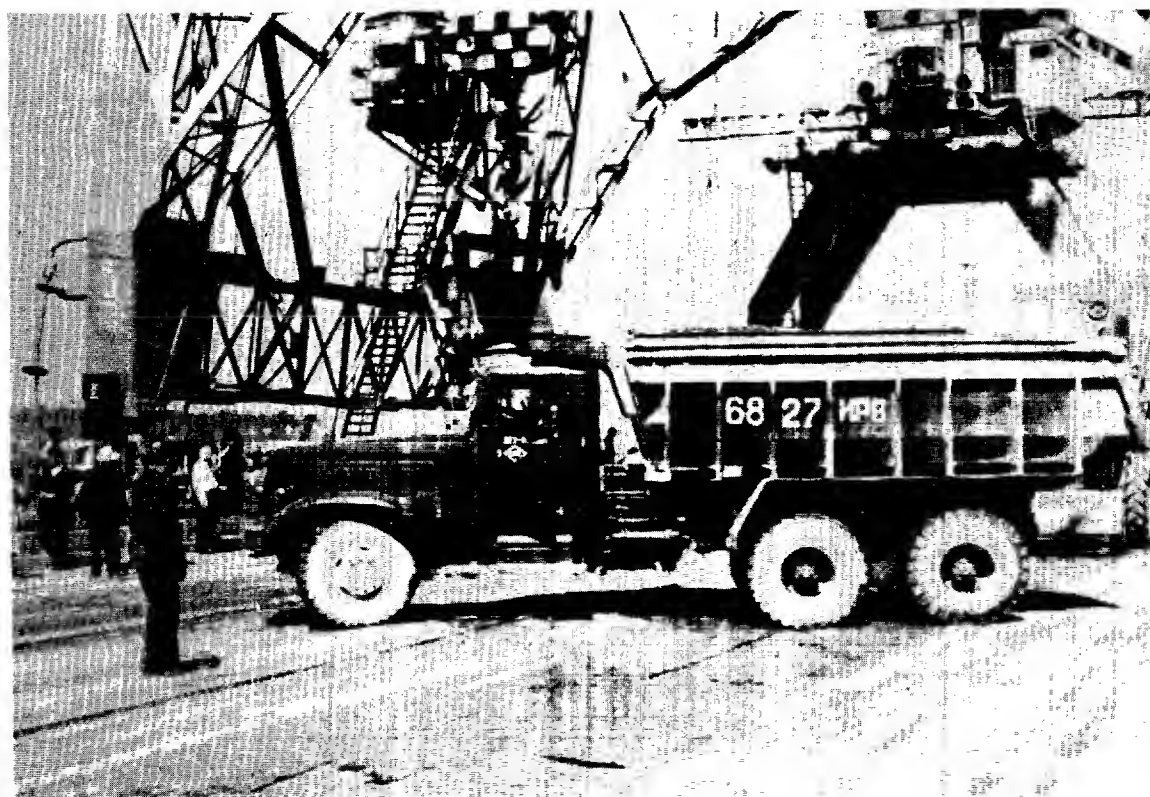
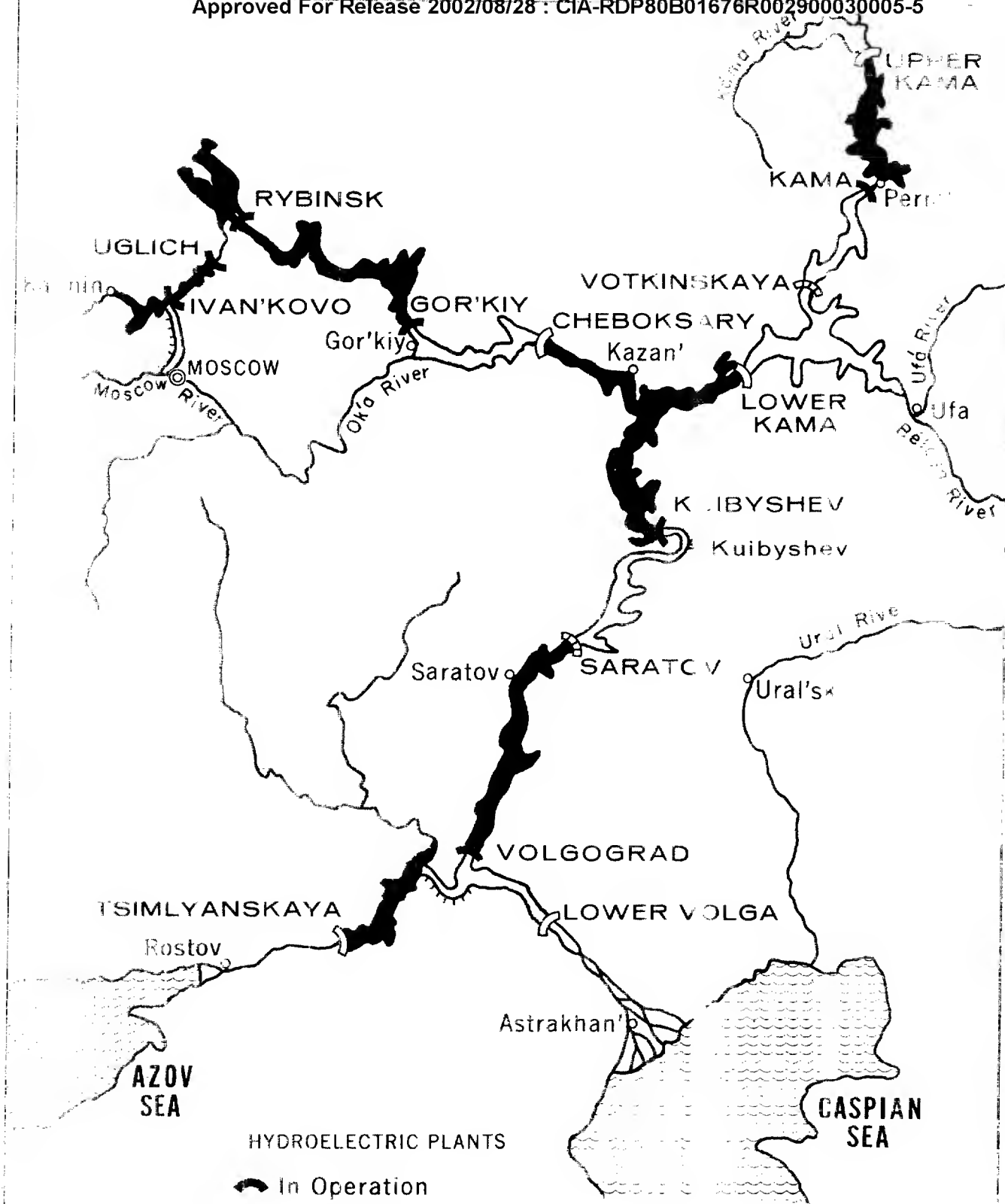


Figure 6 - Heavy truck used for hauling concrete



HYDROELECTRIC PLANTS

— In Operation

- - - Under Construction

--- Proposed

## VOLGA RIVER BASIN DAMS

the U.S.S.R.; and the life of the equipment is figured at the prescribed 16 years.

At the height of construction, some 45,000 workers and 3,500 automobiles and trucks were on the site.

Power needed during construction of the project comes from Irkutsk.

Power generated at Bratsk will be transmitted at 500 kilovolts and will go to industries in the surrounding area: iron and steel works, the lumber industry, and particularly to an aluminum plant now being built 20 miles to the west. The aluminum plant, when finished, will produce more than all the aluminum plants in the Pacific Northwest of the United States combined. It will use 16 billion kilowatt-hours a year, mainly from Bratsk, but also from other sources. The bauxite will come from the deposits at Krasnoyarsk, about 310 miles from Bratsk.

#### Kuibyshev

The Kuibyshev Dam, on the Volga River east of Volgograd, was completed in 1957. It is an earth-filled structure, 12,405 feet long, with navigation locks for the heavy traffic along the Volga River. The powerhouse is built on river sand and was designed for a 16-inch settlement, of which 10 inches have already occurred.

The powerplant consists of twenty 115,000-kilowatt units, for a total capacity of 2,300,000 kilowatts, and transmits power to Moscow at 400 kilovolts; these lines are being converted to 500 kilovolts a-c. The existing 500-kilovolt line serves heavy industry in the Ural Mountains region.

### Volgograd

The town of Volgograd, on the Volga River, was previously Stalingrad, and the dam completed across the river at that place in 1961 was known as the Stalingrad Dam. Recently, the powerplant was formally named "The Twenty-second Congress of the Communist Party of the Soviet Union Volga Power Station," but is commonly referred to as the Volgograd plant. This is but one of nine hydro-plants on the Volga River.

The dam consists of a concrete overflow section with hydraulic-fill earth wings. It has two navigation locks. The dam is 16,080 feet long and 154 feet high and backs up a reservoir containing 27,159,000 acre-feet of water, slightly less than the quantity in Lake Mead behind Hoover Dam. The spillway will pass a flood of 2,100,000 cubic feet per second.

The powerplant houses 22 units of 115,000 kilowatts each, having a total capacity of 2,530,000 kilowatts and generating 11 billion kilowatt-hours a year. The power is delivered to Moscow via two 500-kv. transmission lines and to the Volgograd, Saratov and Astra-Kavsk Oblasts over 220-kv. lines. These will be augmented by a 300-mile 800-kv. d-c line to the Donets Basin; this line was nearing completion at the time of the delegation's visit and since has been energized at reduced voltage.

Through the Volga-Ural canal, the reservoir will supply irrigation water to 2-1/2 million acres or more of arid land.

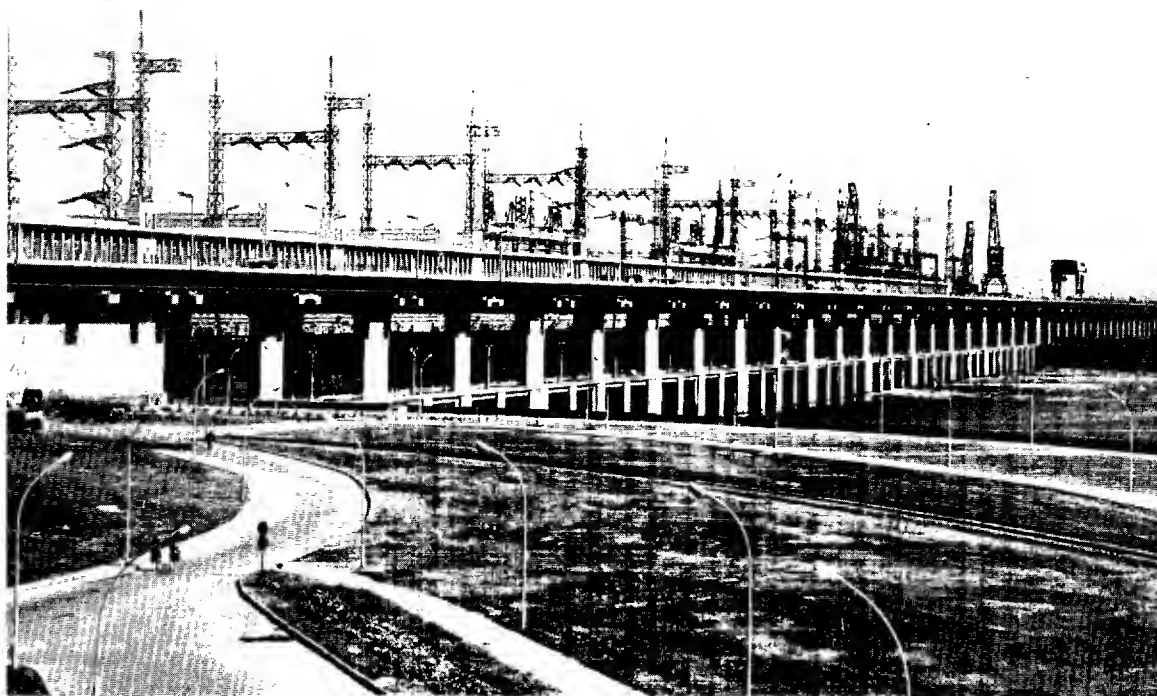


Figure 8 - Volgograd Hydroelectric Plant

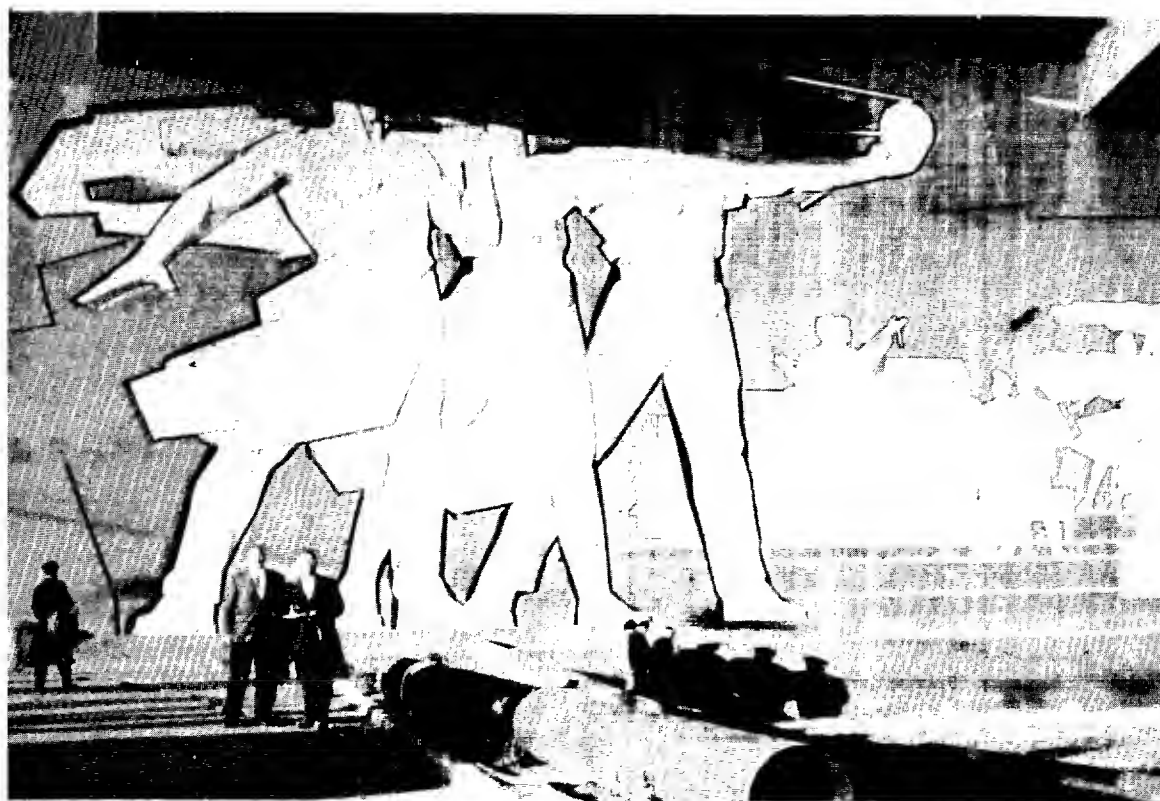


Figure 9 - Entrance to Volgograd Plant

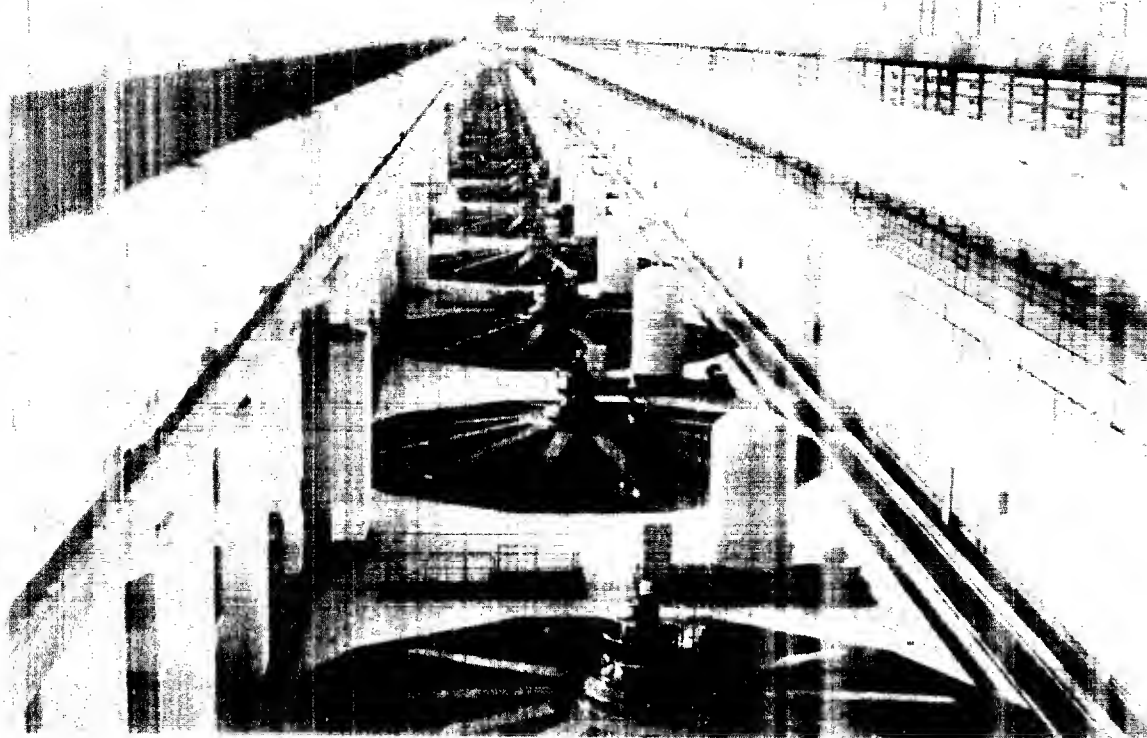


Figure 1. View of the 100-kilowatt generating units at the V. I. Lenin power plant.

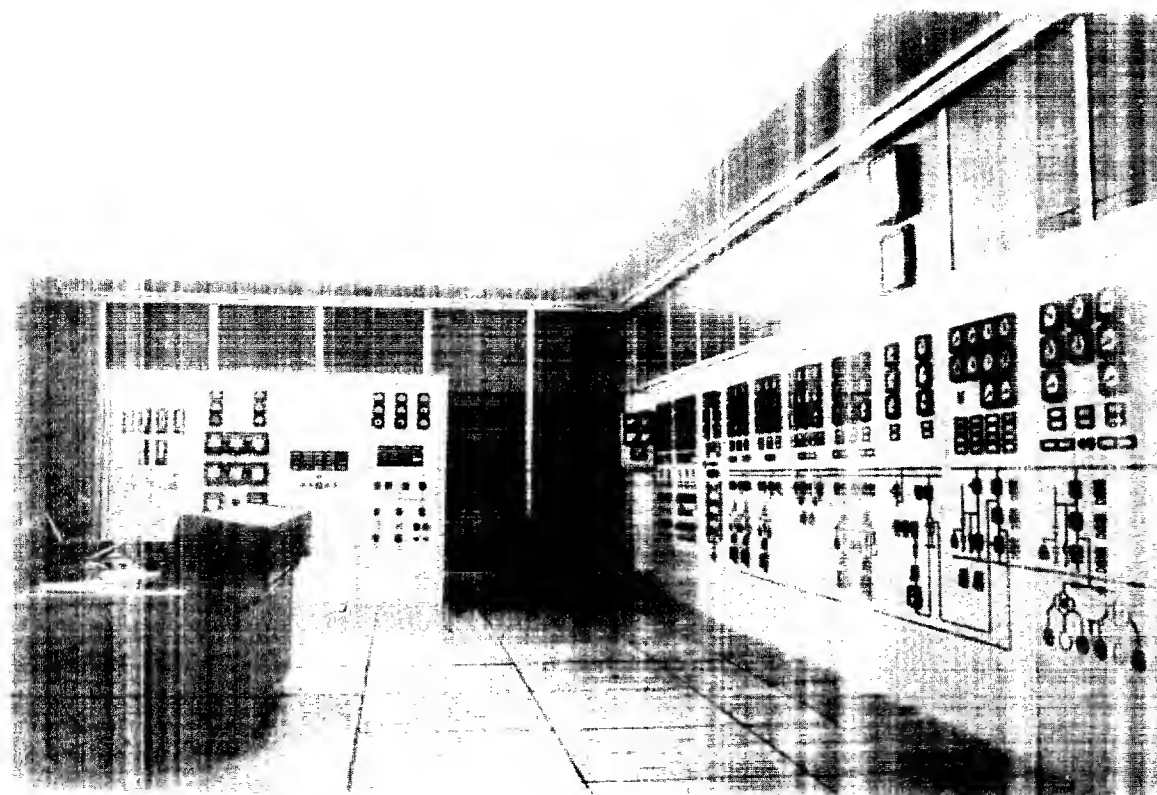


Figure 2. Control room at the V. I. Lenin power plant.

Chaguinskai Substation

The Chaguinskai substation is on the outskirts of Moscow. It receives 1,500,000 kilowatts over two 500-kilovolt lines, and during 1961 and 1962 moved an average of 2 billion kilowatt-hours a year. The American group was told that transmission losses average six percent. At full load, the losses reach seven percent; four percent are in transmission, with 80-90 percent of this in corona.

The oil circuit-breakers have a capacity of 20 million kilovolt-amperes. A synchronous condenser is connected to each transformer bank.

## PART II. SWEDISH AND ENGLISH INSTALLATIONS VISITED

Both Sweden and England have pioneered in developing direct-current transmission of electricity. A 100-kilovolt submarine cable to carry power from the Swedish mainland to the Island of Gotland was completed in 1954; and a 200-kilovolt submarine cable, capable of transmitting power in either direction, went into service across the English Channel in December 1961.

Accordingly, it was decided that Under Secretary of the Interior James K. Carr would head a six-man group to visit Sweden and England, observe installations and exchange technical information. Others in the group were Paul E. Shaad, Charles F. Luce, Howard Morgan, Fred Chambers, and T. W. Mermel.

In Sweden, at the Allmanne Svenska Elektriska Aktiebolag (ASEA) Shops, the American party saw the prototype valve for the extra-high-voltage d-c system soon to connect the North and South Islands of New Zealand via a 600-megawatt 500-kv. circuit, 385 miles long. Both overhead lines and submarine cable are to be used in the installation.

Fundamental research is in progress at Ludvika, Sweden, on mercury-arc phenomena and related matters. Increases in valve readings and simplification through reduction in the number of control grids are the desired goals. But valves of sufficient rating for very large EHV d-c transmission systems are already available from this company.



In England, the cross-channel d-c transmission system, connecting Great Britain with the Continent, was visited and, following this, the facilities of the English Electric Company at Stafford, where much additional research has been carried out on high voltage, high current, mercury-arc valves. Here the design trend is toward a single anode, high current, high voltage valve of rugged, sealed-off construction. Components used in the manufacture of such valves were shown the delegates, as well as the equipment which, in cooperation with the Central Electricity Generating Board of Great Britain, will test valves of the latest design under full operating voltage and current. In addition, these valves will undergo accelerated life testing.

The conclusion reached from these visits was, in essence, a confirmation that satisfactory equipment is currently available for EHV d-c transmission systems, as evidenced by installations already in operation in Sweden and Great Britain and as evidenced by recently placed orders for equipment to be installed in New Zealand, Japan, and Italy.

### PART III. SOVIET TECHNOLOGY

Soviet technology is a functional, a utilitarian technology-- use whatever is needed, however valuable, do whatever is needed, but spend little or nothing on nonessentials. Often Chairman Khrushchev has scolded his engineers for lax engineering methods in one circumstance while scolding them bitterly for too much attention in another. He was caustically critical, for example, of the superintendent of construction at Novosibirsk for "the incorrect use . . . of a walking excavator . . . that did not move (because) there was no room to do so."

Here and there, as noted below, the engineer members of the United States party observed practices that were below United States standards, but the structures, the methods, were adequate for the purpose, and the Soviet engineers appeared to know what they were doing.

#### Dams

Always in the forefront of the thinking of Soviet power managers is the period 1975-1980--the period when the U.S.S.R. plans to overtake the United States in electric power production. Placards adorn the walls of power stations to remind them of their goals. With time weighing so heavily upon them, Soviet engineers place correspondingly heavy emphasis on speed of construction. There appears to be a generally high level of technical competence among Russian engineers, and a laudable willingness to accept technological innovations. However, these innovations, usually adopted to speed construction, are unacceptable by United States standards because of risks they may involve.

Within the dimensions set by their climate, their special relation between the cost of labor and the cost of material, and

particularly the desire for speed, Soviet construction practices are quite effective. Designs are modern, in some cases unconventional and even daring. Design is centralized in a single agency, and full advantage is taken of plans that had proven good in previous construction.

Most of their experience has been with large, low dams, and they tend primarily to favor earth-fill dams. The seeding of unrocked slopes appears not to be done, and considerable ravelling was observed. Less emphasis seems to be placed on testing of the foundation than in the United States, considerable reliance being placed on modification of design after the foundations are opened. If this is so, it must have considerable effect on costs. Eventually they may encounter major difficulties on their large, high, concrete and rock-fill dams.

In contrast, reservoir sites are cleared thoroughly and competently. (At Bratsk all types of timber were salvaged; those unsuitable for sawmill use were rafted to a cellulose plant under construction. This plant will be one of the early users of Bratsk power.) River diversion in most major projects has been by two-stage cofferdamming and final closure by mass dumping of rock and concrete blocks from trestle or pontoon bridge. Grouting pressures appear to be considerably higher than in the United States under similar conditions, but the American delegation did not learn the reasons. Spillway capacities, the visitors were told, were designed on the basis of the 100-year flood, which, if true, would provide less protection than the capacity base used in the United States.

As was done by Aluminum, Ltd., at Kitimat in British Columbia, Soviet engineers design the powerhouses for differential settling. Kuibyshev is an example. In some cases, as at Irkutsk, there have been periodic lateral movements of sections of earth fill, presumably resulting from sudden settlings in lower sections. The visiting delegation saw core drilling in progress along the upstream face at Irkutsk to obtain data on the deep portions of the fill.

The construction equipment observed by the visitors was effectively designed and adequately maintained. The Soviets use tractors more than United States and employ less large earth-moving equipment. Dump trucks are large and, together with hydraulic pipelines, are the usual means of moving large volumes of earth into a dam. No equipment for compacting the earth was seen, and conversation with guides indicated that Russians often rely on truck compaction, as at Irkutsk, although one reference was made to past use of an improvised vibrating roller. Well-built tower cranes and heavy hammerheads, skillfully handled, are normal.

Equipment was abundant, and little of it was idle. Most workmanship was well below the standards of the United States, but the end product was adequate; still, large expenditures may ultimately be required to keep the structures in good operating condition. Few job-safety devices or practices were seen.

Concrete plants are conventional and effective. At Bratsk, the plant is a mile and a half downstream, and delivery of the concrete must take at least 30 minutes from mixer to form. The concrete

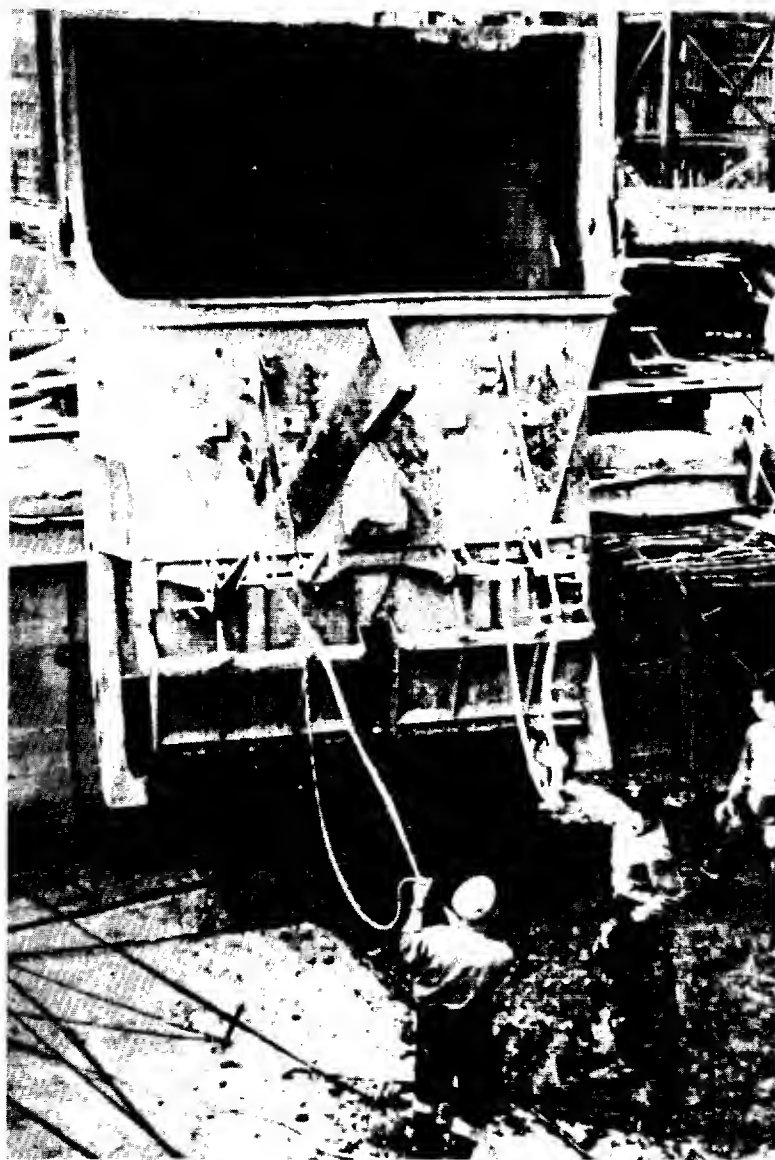


Figure 12 - This 8-1/2 cubic-yard bucket used to place concrete at Bratsk Dam is of unique design

is handled in unusual but efficient skip-type buckets. Local aggregate is used. Gradations in the aggregate from sand to gravel do not appear to be as carefully controlled as in the United States, yet texture and slump characteristics appear adequate. Mass pours were observed in which maximum aggregate size was 2-1/2 inches. No specific information was available on additives.

Such good economies have been achieved, from the Soviet point of view, by use of precast reinforced concrete in building construction that this technique is being applied extensively in heavy construction. The delegation was told that 30 percent of the concrete used in hydroelectric stations is precast, and at Bratsk considerable use of it was observed. The powerhouse building had precast columns, curtain walls, beams, roofs, girders, and decking.

The reasons given are reduction in cost, elimination of on-site forms, elimination of handling activities that would interfere with other work, concrete of more uniform quality than can be obtained if mixed on the site, avoidance of crowding of workers in work areas that are already overcrowded, and accelerated completion of the final structure. While some of the foregoing arguments are plausible, the major reason would seem to be a willingness to trade manpower for time in order to complete construction as fast as possible. The outdoor working season is very short in most of the U.S.S.R., extreme freezing temperatures are encountered, there is a shortage of trained concrete workers and of carpenters skilled in making forms, and there is a tremendous sense of urgency. The

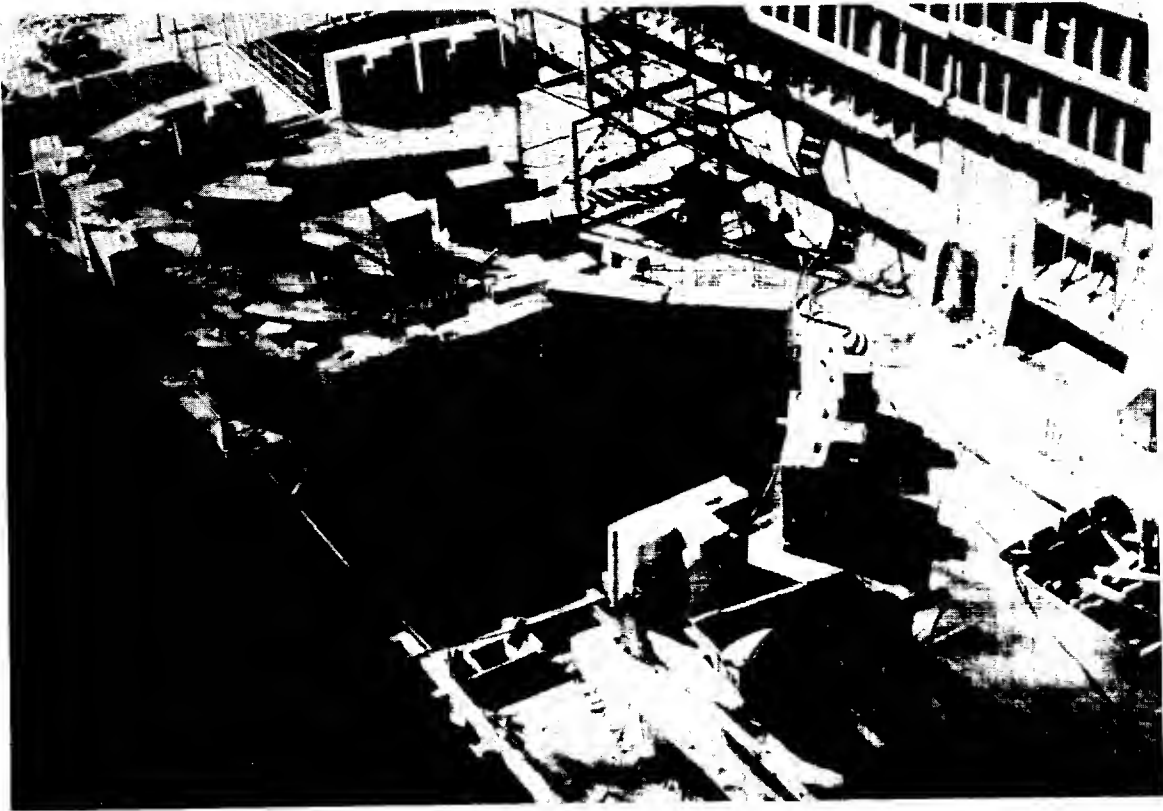


Figure 13 - Precast concrete blocks used at Bratsk Dam

use of precast elements is a nationwide adaptation in apartment buildings, office buildings, bridges, roads, airports, transmission tower footings, and other construction. Some of the elements weighing as much as 20 tons. The standardization of sizes and the mass production of those elements are impressive.

Costs--Comparison of unit costs with those in the United States is difficult. The cost of labor and equipment varies so much from ours, their bookkeeping practices are so different, and the relative value of the dollar and the ruble is so ambiguous that cost comparisons can be misleading. The direct costs of labor and equipment are less than in the United States, as is also the cost of material, and there is no doubt that there are more men and more equipment on a job of given size in the U.S.S.R. than in the United States. According to data given to the delegation, hydroelectric plants built in the U.S.S.R. in 1958 cost an average of \$380 per kilowatt of capacity; in 1962 the cost was down to \$180 per kilowatt; and the Soviets hope to reduce it to \$117 by 1980.

Amortization of dams and powerhouses follows what is apparently a prescribed pattern of a 16-year life for the equipment and a 100-year life for the major structures. On that basis, the projects observed would have a favorable benefit-to-cost ratio if analyzed by the procedures and formulas normally used in the United States. At Bratsk, the power is priced so as to amortize the cost of the dam in 25 years. The costs, however, include neither the cost of the reservoir nor a component for interest.



Manpower--Everywhere ample construction manpower was available, women as well as men doing heavy labor and both taking pride in it. Women drive trucks, pour concrete and asphalt, shovel, and tamp dirt. Pride of accomplishment was particularly apparent at isolated places such as Bratsk.

Operation and maintenance of completed stations are generally excellent, although staffing for these purposes--as in construction--is much higher than in the United States. There is less use of automation and remote control. At one place, five times as many persons were employed as at hydroplants of equal size in the United States.

#### Hydroelectric Equipment and Operation

Since the rivers in Russia are large and the hydroelectric potential at the various sites is proportionately so, the engineers in the U.S.S.R. have been forced into considering larger generating units than ever used before. Before World War II the largest generators in the world were those at Grand Coulee, having a rating of 108,000 kilowatts. Hydroelectric units of 150,000 kilowatts are now being installed in the United States, and hydroelectric generators of similar size are in use in other countries.

Soviet engineers have now gone well beyond that point in the manufacture, installation, and operation of much of their hydro-generating equipment. Their experience includes twenty 115,000-kilowatt units at Kuibyshev, twenty-two 115,000-kilowatt units at Volgograd, eight 82,500-kilowatt units at Irkutsk, and now six



Figure 14 - Women laborers  
at Bratsk Dam

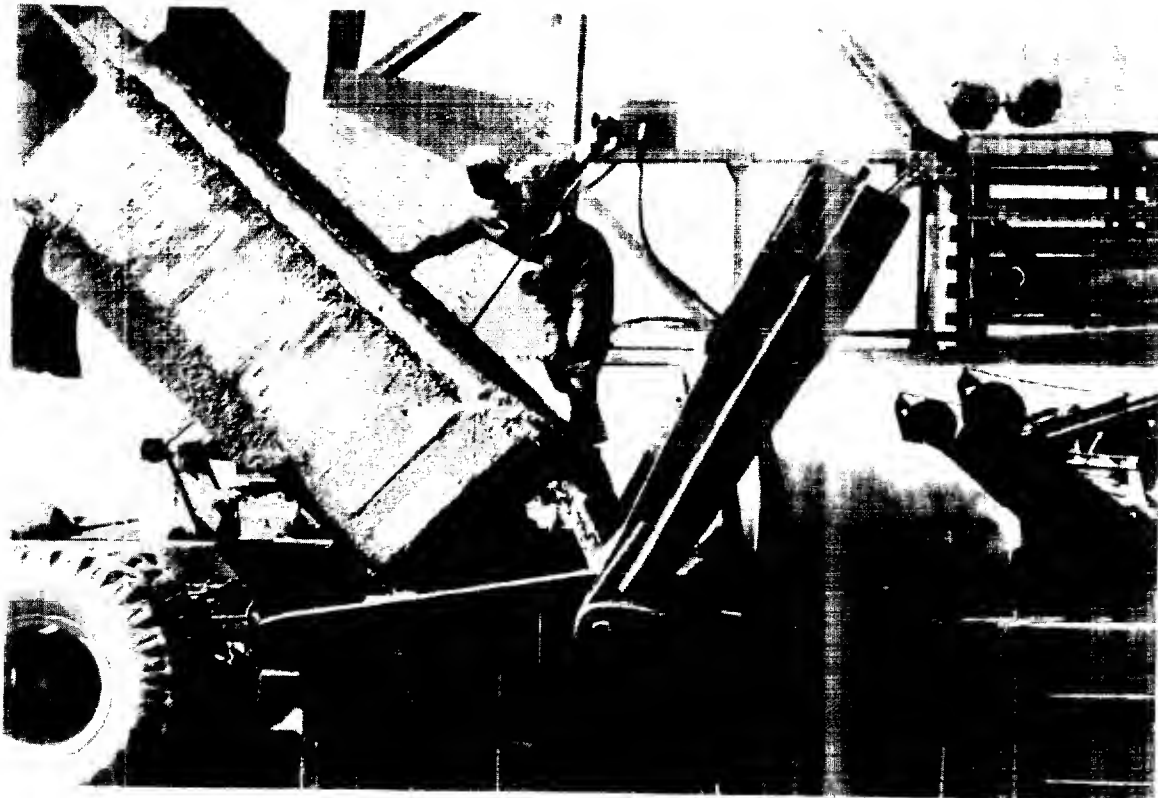


Figure 15 - Woman laborer at Bratsk Dam

operating units of 225,000 kilowatts already installed at Bratsk. There will be twenty such units at the Bratsk plant when it is completed. These are the largest generators ever installed at any hydroplant in the world.

At Volgograd, the visitors saw one of the 115,000-kilowatt units being disassembled in order to equip it with an experimental stator winding cooled with circulating distilled water. The Kaplan turbine associated with this generator was being equipped with a special runner having blades fabricated from stainless steel. Tests were being run on this unit to establish designs for a 500,000-kilowatt generator that will be installed at the Krasnoyarsk station under construction on the Yenisey River. The Soviet engineers were proceeding with apparent confidence on the design of these supersize generators, expecting to have their design confirmed by the experimental unit at Volgograd. Twelve such units will be installed at Krasnoyarsk.

The larger the generator, necessarily the larger the shaft. In the United States, such shafts are forged from a single billet. In the U.S.S.R., either because the forgings required exceed the capacity of the mills or because Soviet engineers believe it to be more economical, the shafts are made hollow, fabricated by welding together plate-steel sections rolled and welded into a cylinder, with flanges welded to the cylinder to complete the shaft. One such hollow shaft is shown in the accompanying photograph.

Smaller-diameter hollow shafts also are used by the Russians. The designers claim that hollow shafts require 50 percent less steel

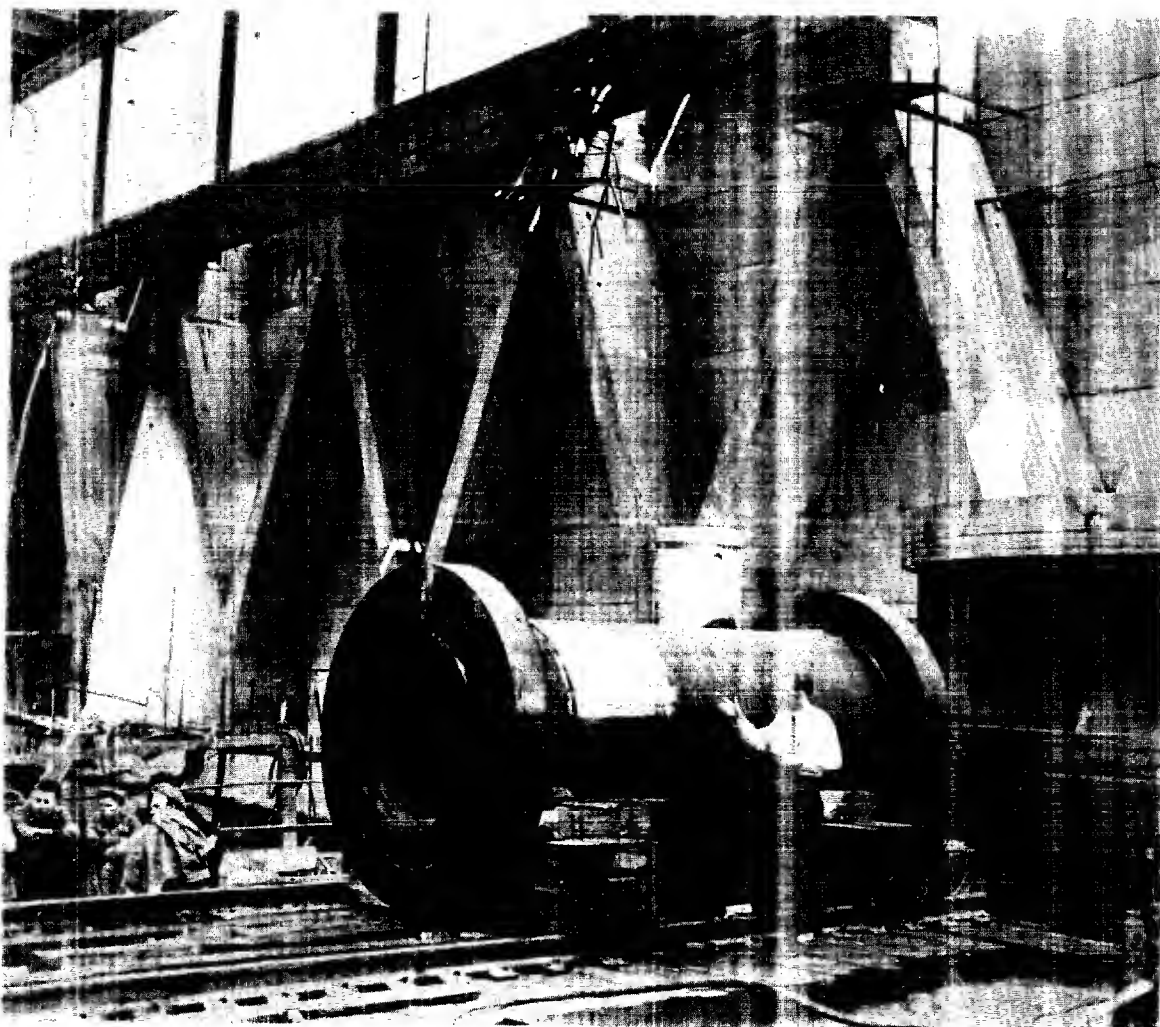


Figure 16 - Hollow welded shaft for 225,000-kv Bratsk generators. The powerhouse wall and roof are of precast concrete.

than solid ones and that savings in the present hydroelectric program approach 1,000 tons a year. Large monetary savings also are claimed because of less machining and handling.

Although the American group observed no such installations, Soviet engineers are intensely interested in horizontal-shaft, bulb-type turbines.

A point of special interest to the electrical engineer is the use of grid-control, mercury-arc rectifiers for supplying field excitation to the supsize generators. The Russians refer to this as ionic excitation. Alternating current to the rectifiers is from a separate stator inconspicuously mounted above the main stator; a companion field-rotor is mounted on the main generator shaft. Similar excitation schemes have found limited use in the United States.

Pumped storage is being developed on the Dnieper River near Kiev. Other situations also were observed where the physical conditions are ideal for pumped storage.

#### Extra-High-Voltage (EHV) Transmission

Alternating Current--The Soviet Union has been moving electricity at 400-kv. since 1954. The Soviet Union put its first 500-kv. line into service in 1961, and the United States party noted

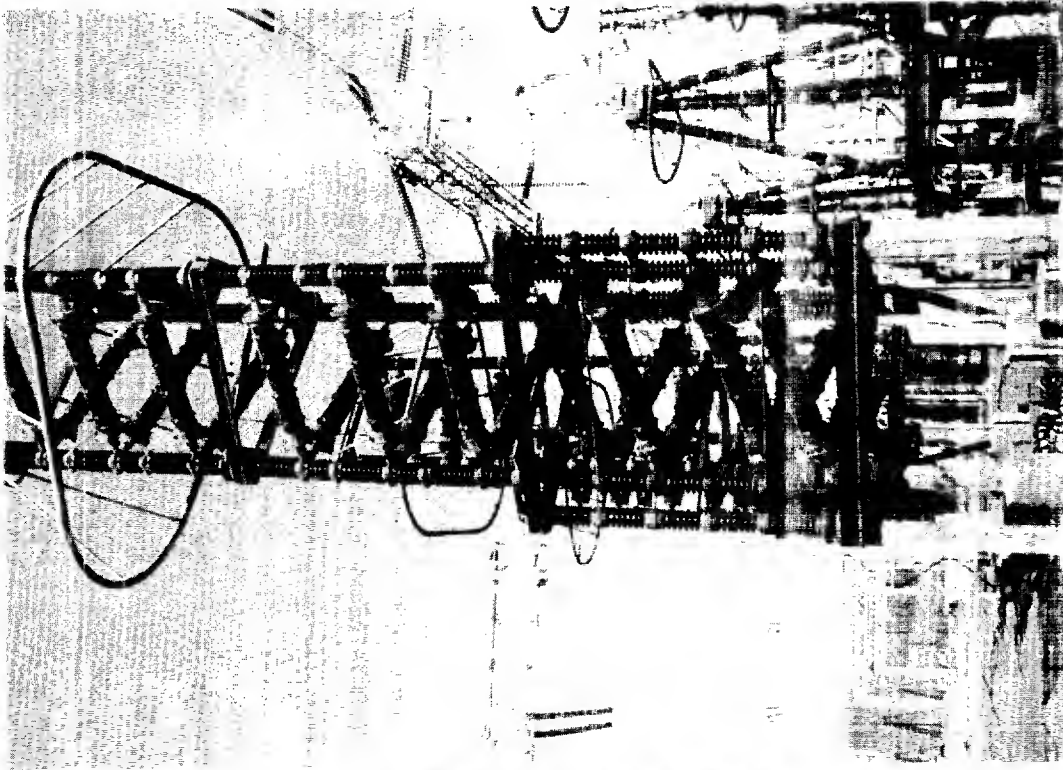


Figure 16 - 500 KV lightning arrester.

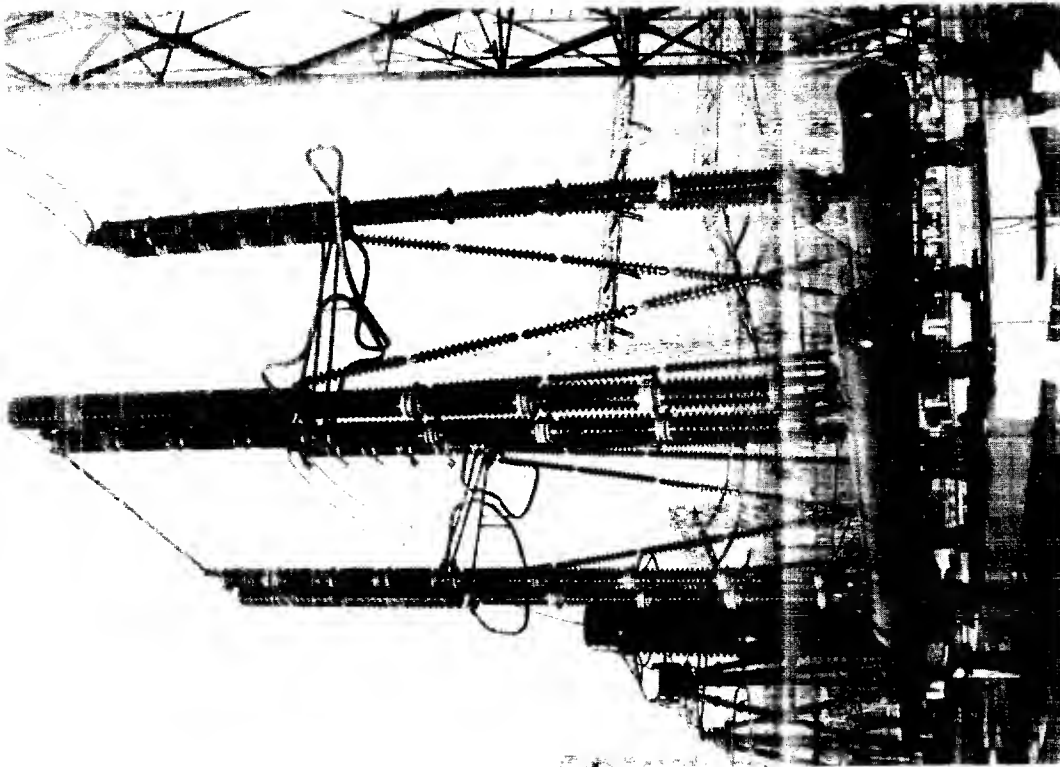


Figure 17 - 500 KV Air Blast Circuit Breaker



Figure 19 - 500 KV Disconnect Switches

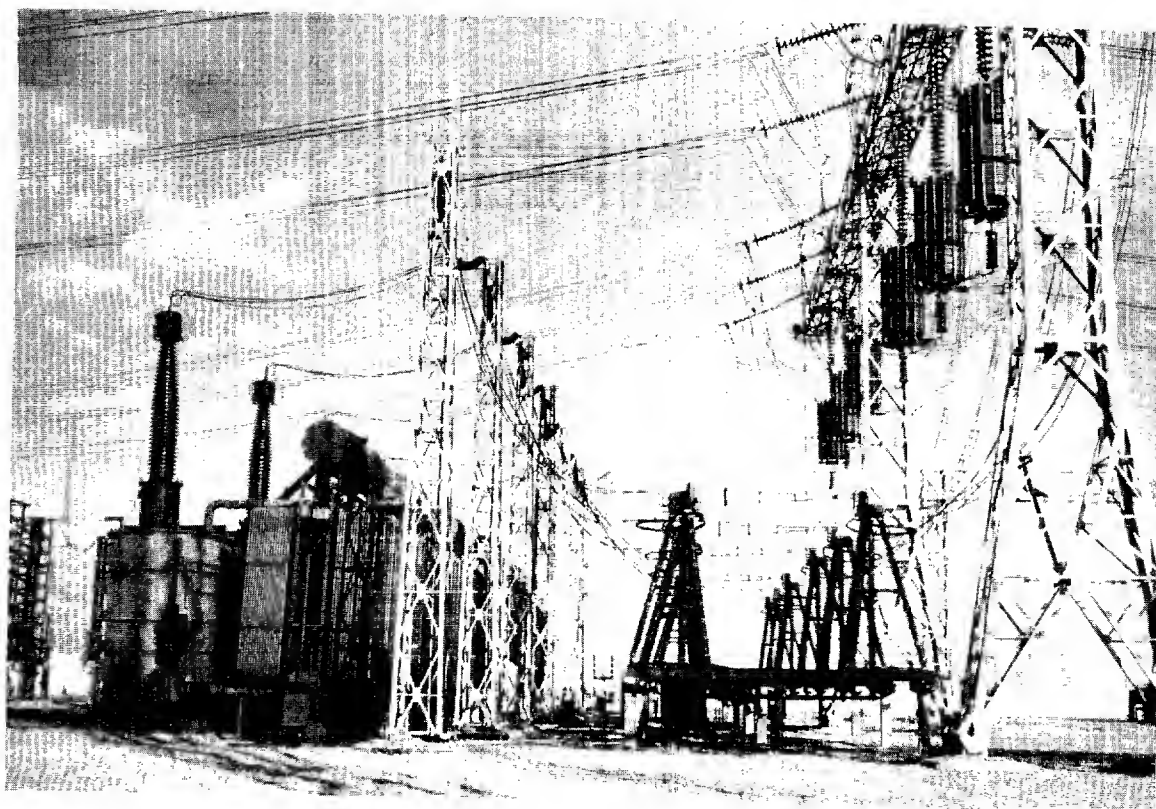


Figure 20 - Left to right: 500 KV lightning arresters for reactor protection, Shunt reactors, Reactor disconnect switches, Carrier current line traps

progress in converting the existing 400-kv. lines to the higher level. The principal alteration required is in transformer and reactor windings. A transformer-winding replacement was observed in progress at Volgograd.

Early in 1962, the U.S.S.R. announced that the next change would be to 750-kv.; the United States visitors were told that a 70-mile test line is to be constructed in connection with the Kanova steamplant near Moscow and that it will be ready for testing in 1964.

Performance of the 400-kv.-500-kv. system is reported as uniformly satisfactory. This system interconnects the Central, Southern, and Urals power pools to form the largest of the Soviet integrated systems. It is later to be expanded, through interconnections, with the Siberian system and with other lesser systems south and west. Either 750-kv. a-c or EHV d-c may be used for these long interconnections.

Direct Current--Since 1952, the U.S.S.R. has been operating a 200-kv. (100 kv.  $\pm$ ) experimental line bringing power 70 miles from Kashira to Moscow; and based upon that experience, it has been building an 800-kv. (400 kv.  $\pm$ ) line 292 miles from Volgograd to the Donbass industrial center in the Donets Basin. Engineers outside the U.S.S.R. have long awaited completion of this line and reports on its operation. The United States group observed portions of the completed line and of the as-yet uncompleted terminal facilities at the Volgograd end. Soviet engineers forecast operation on reduced



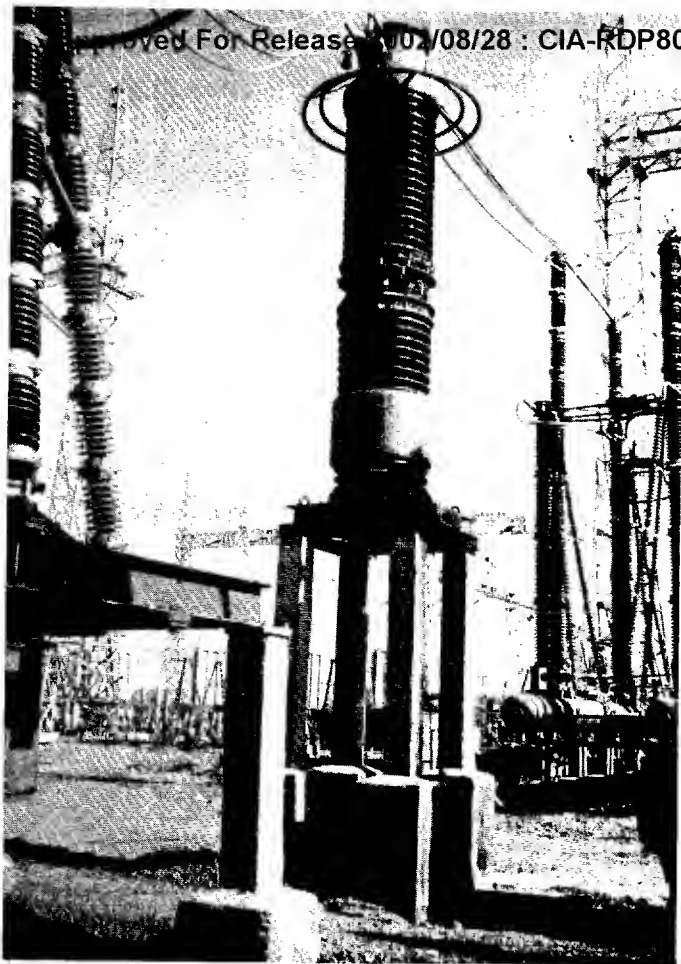
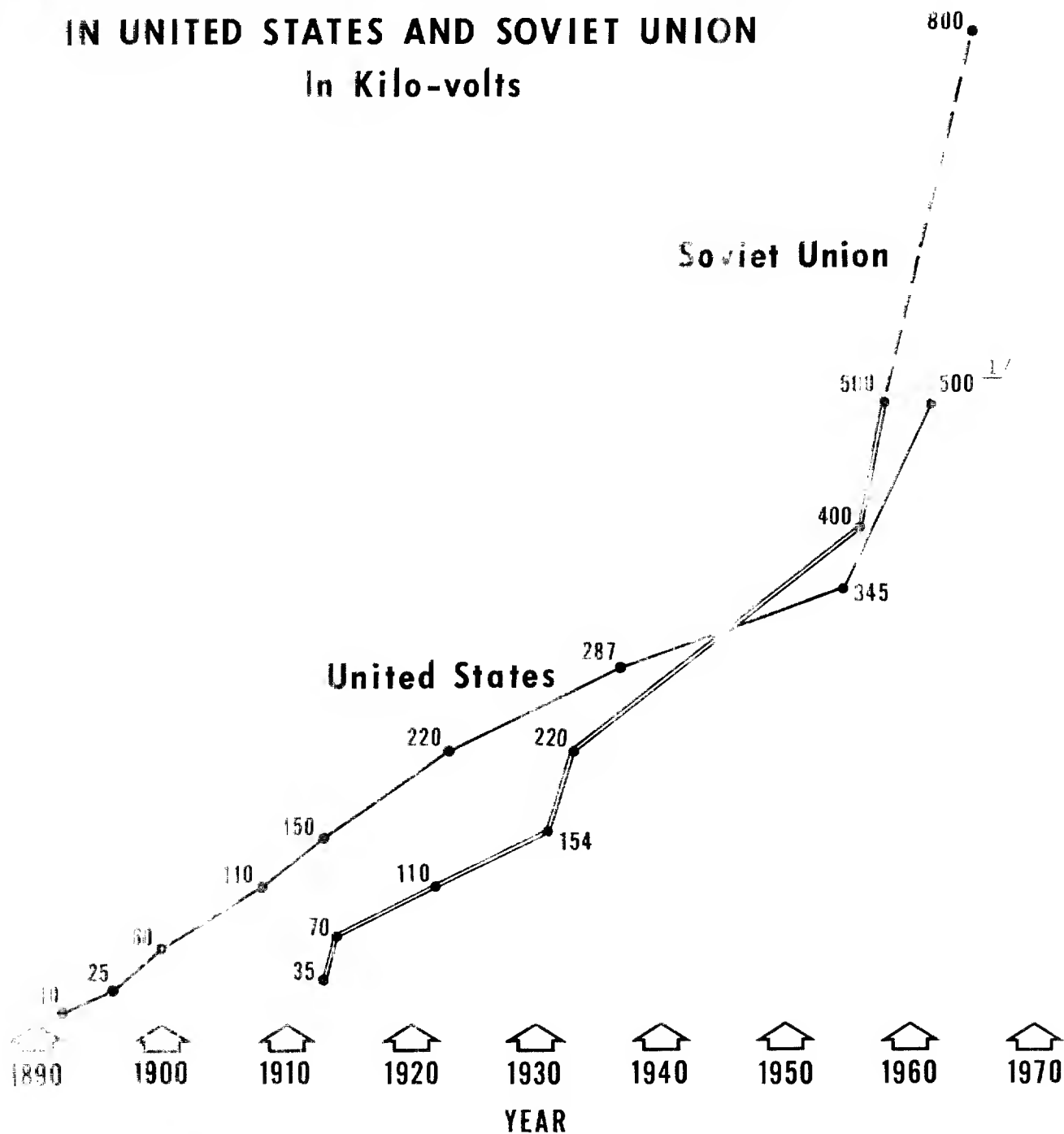


Figure 21 - 500 KV Current transformer



Figure 22 - "Don't climb  
- it kills"

# INCREASES IN TRANSMISSION LINE VOLTAGES IN UNITED STATES AND SOVIET UNION In Kilo-volts



13 mile segment  
U.S. Data - Federal Power Commission

Figure 23

voltage before the end of 1962 and at full voltage by 1965; the press reported on October 31, 1962, that the line was, in fact, energized on October 29 but at reduced voltage for experimental purposes. The visiting group was told that initial operation would be with one 100-kv. bridge on either side of ground potential and with two valves in series at each valve position in each bridge. Difficulty has been encountered in producing satisfactory valves of the desired voltage and current rating, but we learned nothing about the exact nature of this difficulty. At the Moscow terminal of the Moscow-Kashira system, the observers saw valves of various designs under operational tests.

The goal is a 1,400-kv. system capable of delivering 4,000 megawatts per circuit for long distances.

There is no d-c transmission in the United States, although some experimenting had been done before World War II, and the Department of the Interior had made earlier studies of possible d-c transmission from the Pacific Northwest 1,800 miles to Chicago. The obstacle was lack of equipment to connect the a-c current generated to the d-c current for transmission, and this obstacle was not overcome until 1952 when Swedish engineers perfected the equipment that some of the United States party saw at Ludvika, as previously described. This year, 1962, The General Electric Company obtained a license from ASEA, the Swedish designer and manufacturer of the conversion valves, and Congress authorized the Bonneville Power Administration to build a five-mile, 1,100,000-volt direct-current test line.

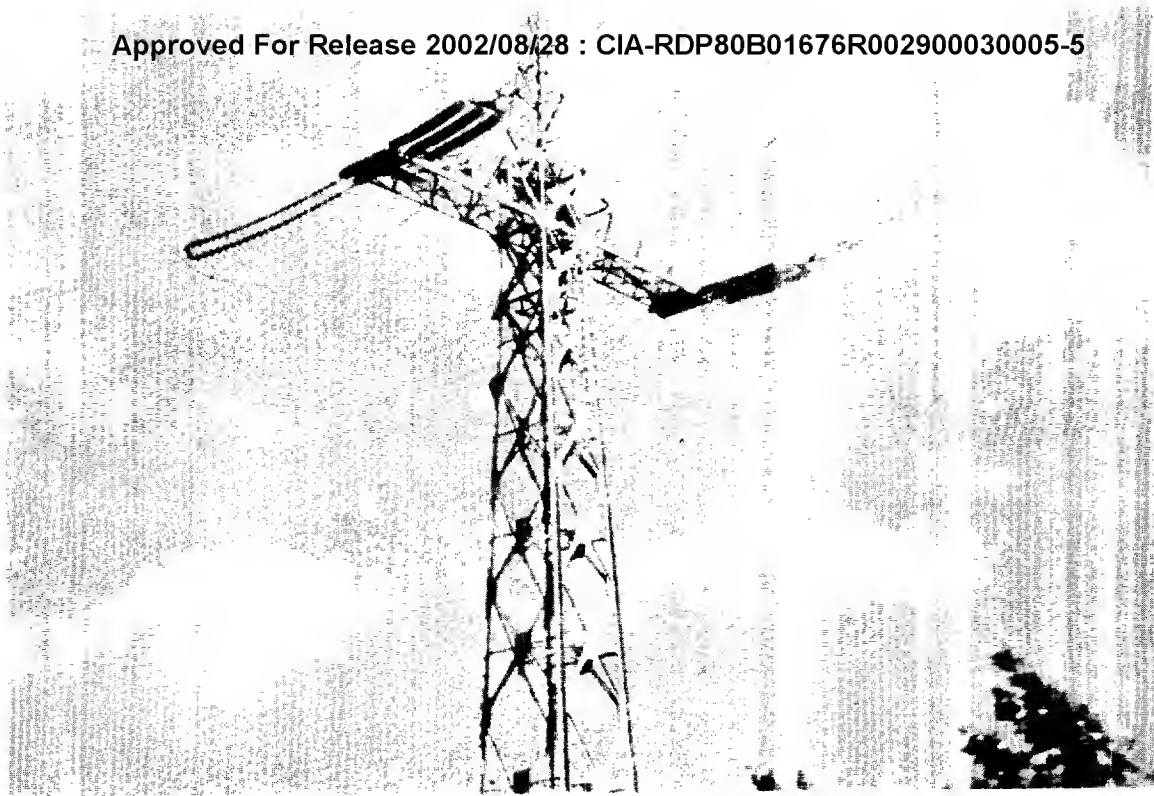


Figure 24 - 800 KV Direct Current transmission tower -- stringing of conductors in progress

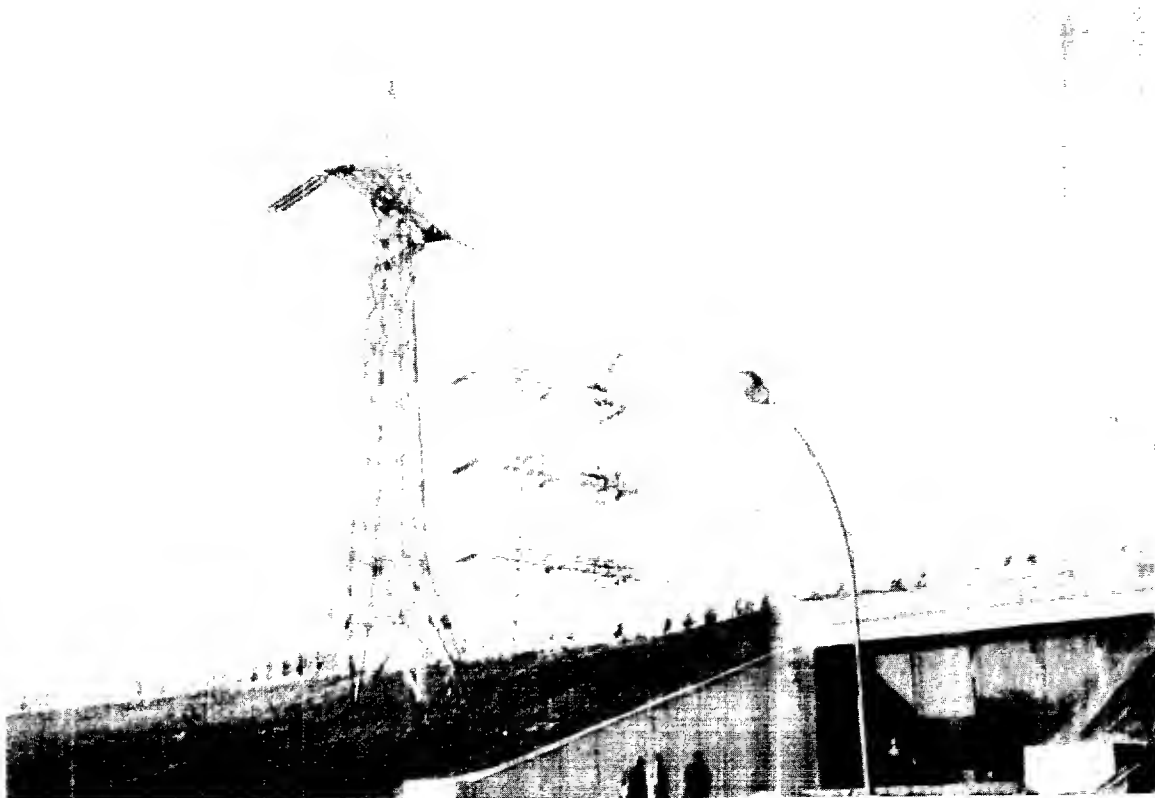


Figure 25 - 800 KV Direct Current transmission tower in foreground -- 500 KV A.C. towers in background at Volgograd

### Centralized Dispatching

All power installations between Siberia and European Russia, both hydroelectric and steam and totaling some 30 million kilowatts of installed capacity, are interconnected and are controlled from a central dispatcher's office of the Unified European Electric Power System in Moscow. Thirty-two of the country's 55 power systems are involved.

The center uses all modern systems of communication to deliver information on pertinent loads and for the transmission of dispatch instructions. Considerable effort was being made to provide the most economic dispatch as determined by digital computers and an analog system board for determination of power flows. Additional analog equipment was available for use on special studies, and other computers and analog equipment were available at other locations.

In the long-range plan, the entire Soviet-European and Siberian power systems will be interconnected and dispatched from a central location. This envisions taking advantage of the diversity of loads, differences in river flow, and the pooling requirements for reserve equipment. Considering that the whole of Russia covers 11 time zones and two climatic zones, these differences can be significant.

The scheme is initially to establish regional systems and to interconnect them later with EHV lines. The interconnections began to take shape when the Urals system was connected with the Kuibyshev plant and the Volgograd plant with Moscow. Systems will be established



Figure 26 - Central dispatchers office of the Unified European Electric Power System in Moscow

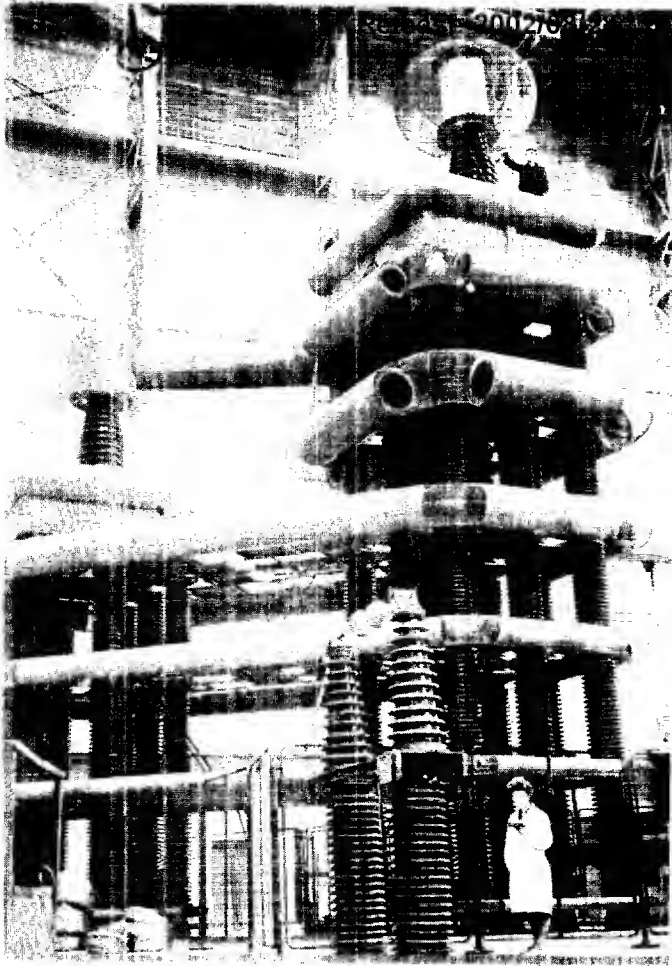
in central Siberia and in the country east and northeast of Lake Baikal. The northwest system, which includes Leningrad, is scheduled to be interconnected with the Estonian and Lithuanian systems before 1965.

#### Research and Development

Research and development, including some design work, is carried out by several institutes, the largest of which are the Electro-Mechanical Institute in Leningrad and the V. I. Lenin All-Union Electrotechnical Institute in Moscow. The United States party visited the latter.

It was at the Electrotechnical Institute that parameters for the Soviet 400-kv. system were drawn and the design made for the equipment necessary to meet these parameters. Here, also, were made the studies leading to the up-rating of the 400-kv. system to 500-kv. At the time of the visit, work was in full swing on the proposed 750-kv. system.

The quiet hospitality and obvious technical abilities of the large group who made the visitors welcome were impressive. The United States party was impressed, too, by the large array of new high-voltage laboratory equipment in use. Some of this had been made especially in connection with the 750-kv. research. It included a high-voltage impulse generator cascade of testing transformers and direct-current cascade generator.



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Figure 1 - Cascade of transformers for testing at 2070 kV

Figure 2 - New extra-high-voltage laboratory in the All-Union Electrotechnical Institute in Leningrad, Moscow





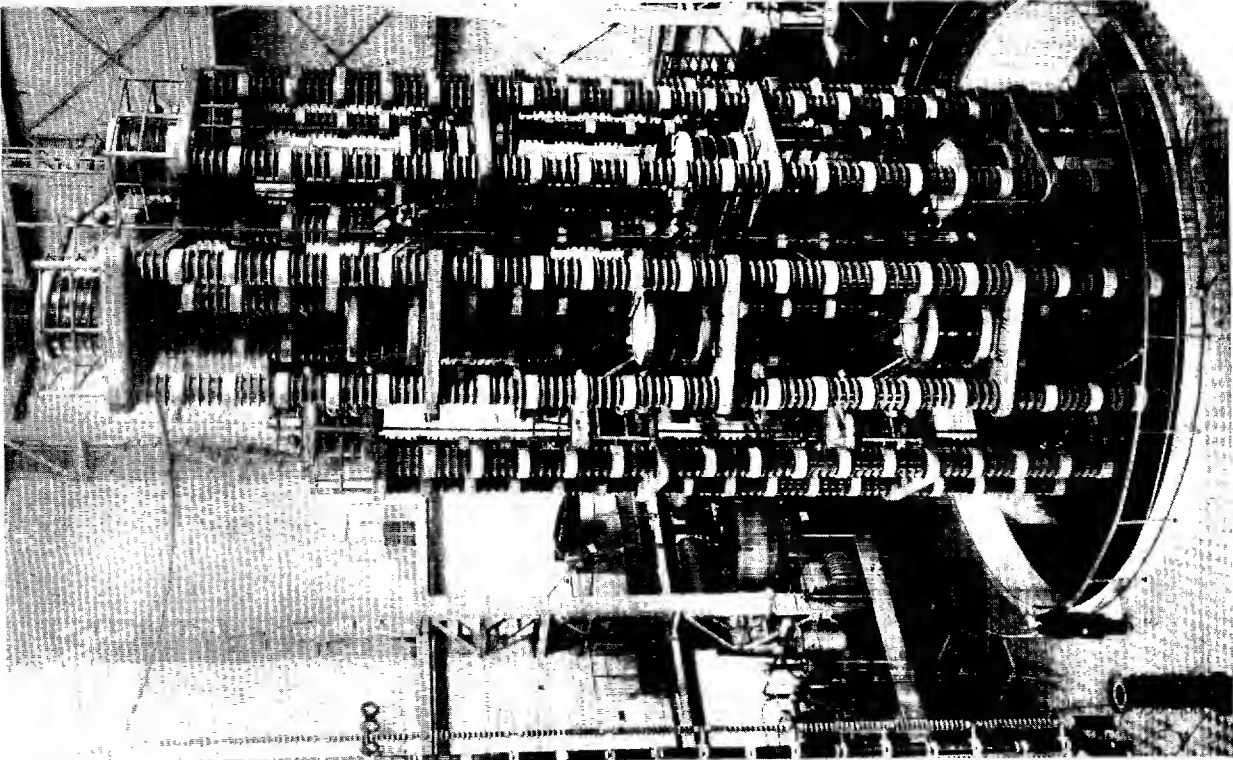


Figure 30 - Impulse voltage generator 7.2 MV  
400 KW-sec.

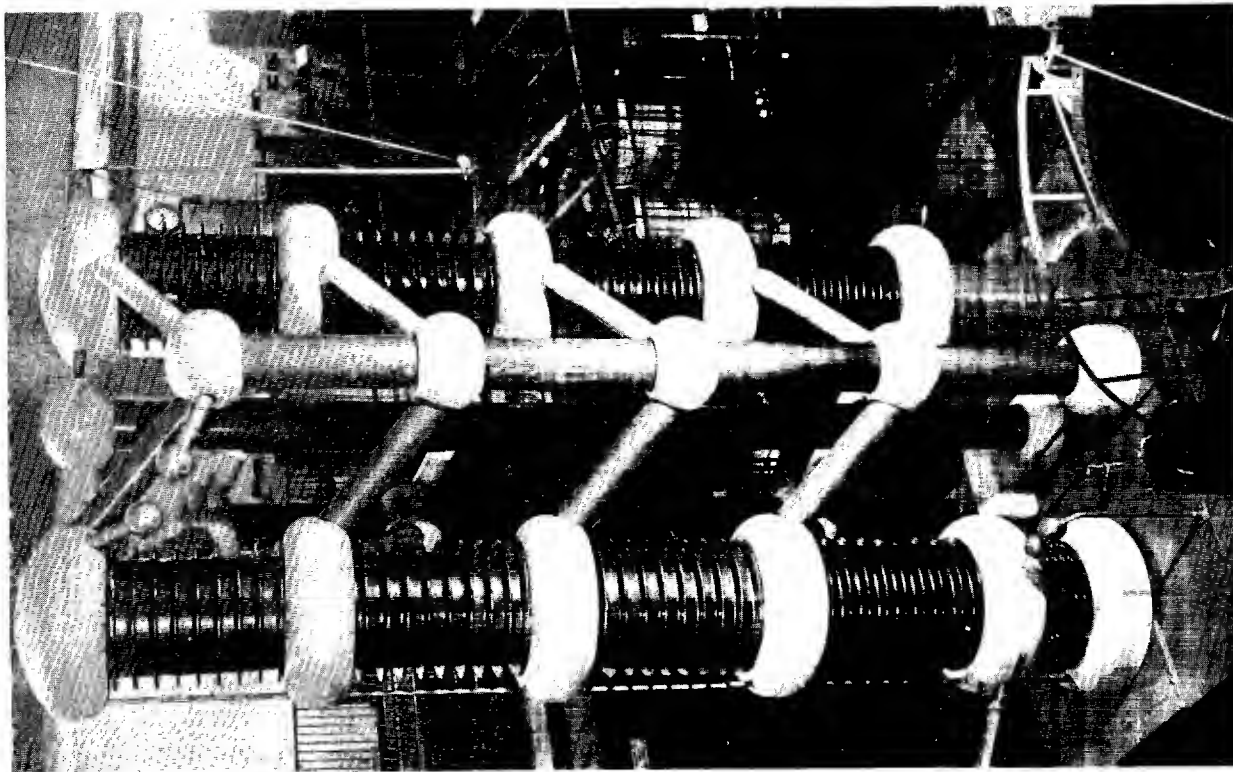


Figure 29 - Direct-current cascade generator  
for testing 800-KV, 50 Ma.

High-power short-circuit testing is not done at this institute, and nowhere did the party see any test equipment of this kind.

As have others, the group left with the conviction that Soviet engineers and scientists proceed with confidence in tackling the imposing problems confronting them in power-system and power-equipment development. They produce good work, much of which is generally described in both the Soviet and foreign technical press.

#### Statistical Comparison of Dams in United States and U.S.S.R.

Following this chapter is a statistical compilation of dams in the United States and the U.S.S.R. compared by height, by volume content and size of reservoir created by dams.

Insofar as high dams in the United States are concerned, the data reveals that the United States has built many high concrete dams dating back many years with Hoover Dam being constructed in 1936 at a height of 726 feet. The highest completed Russian concrete dam is Bukhtarminsk which is 295 feet high. It should be noted, however, that the Russians are commencing the construction of a concrete dam 988 feet high and a rock-fill dam 984 feet high.

The statistics show that the United States has built the largest earth dams in volume content. The Russians have also built several large earth dams. Their experience has been principally in the field of hydraulic fill.

The statistics on large reservoirs created by dams reflect the large rivers in the U.S.S.R.

COMPARISON OF U.S.A. AND U.S.S.R DAMS BY HEIGHT

UNITED STATES' HIGHEST DAMS

RUSSIA'S HIGHEST DAMS

<u>Rank and Name</u>	<u>Height (ft.)</u>	<u>Year Com- pleted</u>
1. Oroville	735 E	UC
2. Hoover	726 C	1936
3. Glen Canyon	710 C	UC
4. Shasta	602 C	1945
5. Hungry Horse	564 C	1953
6. Grand Coulee	550 C	1942
7. Ross	540 C	1949
8. Trinity	537 E	1962
9. Yellowtail	520 C	UC
10. Cougar	515 CRE	UC
11. Swift	512 E	1958
12. Flaming Gorge	502 C	UC
13. Donnell's	484 C	1957
14. Fontana	480 C	1944
15. Carters	464 ER	UC
16. Anderson Ranch	456 E	1950
17. Detroit	454 C	1953
18. Pine Flat	440 C	1954
19. Round Butte	440 R	UC
20. O'Shaughnessy	430 C	1938

<u>Rank and Name</u>	<u>Height (ft.)</u>	<u>Year First Generating Unit Operated</u>
1. Ingurskaya	988 C	UC
2. Nurek	984 R	UC
3. Chirkeyskaia	755 C	A
4. Sayanskaya	738 R	A
5. Charvakskaia	505 R	A
6. Bratsk	410 EC	1961
7. Krasnoyarsk	390 C	UC
8. Zeyskaya	371 RE	A
9. Bukhtarminsk	295 C	1960
10. Syonskaya	278 E	UC
11. Mingechaurskaya	262 H	1953
12. Ladzhanurskaya	226 C	1960
13. Tolorosskaya	223 C	UC
14. Vilyuyskaya	213 R	UC
15. Ust'-Kamenogorsk	213 C	1952
16. Dnieprostroy	203 C	1932
17. Mamakan	190 C	1961
18. Pavlousk	174 CHE	1959
19. Gumatskaya	171 C	1958
20. Upper Tuloma	164 EC	UC

C - Concrete E - Earth R - Rock-fill H - Hydraulic Earth-fill  
UC - Under Construction A - Approved for Construction

## COMPARISON OF U.S.A. AND U.S.S.R. DAMS BY VOLUME

## UNITED STATES: LARGEST DAMS

## RUSSIA'S LARGEST DAMS

Rank and Name	Volume Cubic Yards	Year Completed	Rank and Name	Volume Cubic Yards	Year First Generating Unit Operated
1. Fort Peck	125,600,000 E	1940	1. Sayanskaya	63,300,000 R	A
2. Oahe	92,000,000 E	UC	2. Nurek	58,860,000 R	UC
3. Oroville	78,000,000 E	UC	3. Kiev	58,813,000 HC	UC
4. San Luis	75,000,000 E	UC	4. Kakhouka	46,617,000 HC	1955
5. Garrison	66,500,000 E	1960	5. Tsimlyansk	44,323,000 HC	1952
6. Fort Randall	50,200,000 E	1956	6. Kuibyshev	44,298,000 HC	1955
7. Kingsley	32,000,000 E	1942	7. Kremenchug	36,281,000 HC	1959
8. Trinity	28,986,000 E	1962	8. Dneprodzerzhinsk	35,965,000 HC	UC
9. Navajo	26,250,000 E	1962	9. Volgograd	33,020,000 HC	1958
10. Tuttle Creek	21,000,000 ER	1962	10. Gor'kiy	25,819,000 HC	1955
11. Twin Buttes	21,000,000 E	UC	11. Bratsk	22,240,000 EC	1961
12. Denison	18,800,000 E	1944	12. Charvaksaya	20,930,000 R	A
13. Big Bend	17,300,000 E	UC	13. Mingechaurskaya	20,400,000 H	1953
14. Sardis	16,450,000 E	1940	14. Ivan'kovo	20,207,000 HC	1937
15. Swift	15,430,600 E	1958	15. Zayskaya	17,130,000 RE	A
16. Carters	13,000,000 E	UC	16. Ivankovo	15,118,000 AT	1957
17. Milford	15,000,000 E	UC	17. Votkinskaya	14,948,000 EC	1961
18. Sanford	14,800,000 E	UC	18. Chardarinskaya	12,100,000 H	UC
19. Kanapolis	14,668,000 E	1948	19. Kapchagay	10,350,000 HE	A
20. Hansen	13,990,000 E	1940	20. Saratov	9,533,000 HC	UC

C - Concrete    E - Earth    R - Rock-fill    H - Hydraulic Earth-fill  
 UC - Under Construction    A - Approved for Construction

COMPARISON OF U.S.A. AND U.S.S.R. RESERVOIR CAPACITIES CREATED BY DAMSUNITED STATES' LARGEST RESERVOIRSRUSSIA'S LARGEST RESERVOIRS

Rank and Name of Dam	Capacity Acre-Feet	Year Completed	Rank and Name of Dam	Capacity Acre-Feet	Year First Generating Unit Operated
1. Hoover	31,047,000	1936	1. Bratsk	145,000,000	1961
2. Glen Canyon	28,040,000	UC	2. Zeyskaya	77,800,000	A
3. Garrison	24,500,000	1960	3. Krasnoyarsk	58,400,000	UC
4. Oahe	23,600,000	UC	4. Kuibyshev	47,000,000	1955
5. Fort Peck	19,400,000	1940	5. Bukhtarminsk	43,000,000	1960
6. Grand Coulee	9,402,000	1942	6. Irkutsk	37,300,000	1956
7. Fort Randall	6,100,000	1956	7. Volgograd	27,159,000	1958
8. Wolf Creek	6,089,000	1952	8. Sayanskaya	23,600,000	A
9. Kentucky	6,002,600	1944	9. Sheksninskaya	20,600,000	1941
10. Denison	5,530,000	1944	10. Rybinsk	20,600,000	1941
11. Bull Shoals	5,408,000	1951	11. Tsimlyansk	17,710,000	1952
12. Shasta	4,500,000	1945	12. Vilyayanskaya	15,000,000	UC
13. Toledo Bend	4,447,000	UC	13. Kakhovka	14,800,000	1955
14. McGee Bend	4,040,800	UC	14. Upper Svir'	14,200,000	1952
15. Eufaula	3,848,000	UC	15. Mingechaurskaya	13,000,000	1953
16. Flaming Gorge	3,789,000	UC	16. Kremenchug	10,900,000	1959
17. Oroville	3,484,000	UC	17. Saratov	10,900,000	UC
18. Hungry Horse	3,468,000	1953	18. Kama	9,890,000	1954
19. Table Rock	3,462,000	1959	19. Upper Tuloma	9,320,000	UC
20. Greers Ferry	2,844,000	UC	20. Ivan'kovo	9,080,000	1937

UC = Under Construction

A = Approved for Construction

PART IV SOVIET AND UNITED STATES ENERGY COMPARED

The United States now uses 2-1/3 times as much energy--electrical, thermal, internal combustion, etc.--as the Soviet Union. The Soviet's 1961 use was almost precisely what America's was in 1920. In electric energy alone, the United States uses 2-3/4 times as much as the U.S.S.R.; they are now where we were in 1949. In rate of increase, however, the reverse is true, the Soviet's use of electricity is increasing almost three times as fast as ours.

If all energy in the United States were produced by burning coal, it would average out at ten tons per person each year. In Russia, the per capita consumption would be 3-1/2 tons a year. Their per capita rate is what ours was about 1900; their per capita consumption of electric energy alone is what ours was in 1941.

The statistical foundation for those comments and other comparative information follow (all figures for 1961):

	<u>U.S.S.R.</u>	<u>United States</u>
Population	218 million	184 million
Elements of use:		
Consumption, kw-hrs.	327,000 million	880,000 million
Rate of increase, 1960-61	12.9%	4.5%
Rate of increase, total energy, 1950-61	4.3%/yr.	2.8%/yr.
Per capita, kw-hrs.	1500	4800
Per capita rate of increase, 1960-61	10%	3.5%
Elements of supply:		
Installed capacity, kw.	14,000,000	199,000,000
Reserve capacity, kw.	Unknown	4,300,000
Hydropower as percent of total electric energy	22	18
Hydropower resources, kw-hrs./yr.	2,100 billion	643 billion
Portion of hydropower developed	3%	25%
Highest transmission voltage, kv.	500	345 1/2
Largest hydroplant completed, kw.	2,530,000	2,194,000
Largest hydro-unit capacity, kw.	225,000	150,000

1/ Single 13-mile segment of one line operating at 500,000 volts

Regarding plant and investment to provide the electric energy, we have already called attention to their huge dams and hydroplants. The comparison with ours is shown in the tables on the next three pages. The Soviet Union has two hydroelectric plants under construction much larger than our largest, which will be represented by the one at John Day, Oregon-Washington, with its 2,700,000-kw. ultimate installation.

THE WORLD'S 20 LARGEST HYDROELECTRIC GENERATING PLANTS

<u>Name</u>	<u>Installed Capacity, MW</u>		<u>Date of Initial Operation</u>
	<u>Ultimate</u> <u>1/</u>	<u>Present</u> <u>1/</u>	
KRASNOYARSK, U.S.S.R.	6,000	NA	UC
BRATSK, U.S.S.R.	4,500	4,500	1961
JOHN DAY, U.S.A.	2,700	1,350	UC
NUREK, U.S.S.R.	2,700	NA	UC
VOLGOGRAD, U.S.S.R.	2,530	2,530	1959
Portage Mountain, Canada	2,500	NA	UC
KUIBYSHEV, U.S.S.R.	2,300	2,300	1959
GRAND COULEE, U.S.A.	1,974	1,974	1941
ROBERT MOSES NIAGARA, U.S.A.	1,950	1,950	1961
THE DALLES, U.S.A.	1,749	1,125	1959
CHIEF JOSEPH, U.S.A.	1,728	1,024	1958
Kemano, Canada	1,670	835	1954
Beauharnois, Canada	1,560	1,560	1932
Kariba, Rhodesia	1,500	600	1959
UNGURI, U.S.S.R.	1,400	NA	UC
SARATOV, U.S.S.R.	1,380	NA	UC
Sir Adam Beck No. 2, Canada	1,370	900	1954
HOOVER, U.S.A.	1,345	1,345	1936
WANAPUM, U.S.A.	1,330	831	UC

1/ Ultimate capacity for which provision is made in dam or powerhouse substructure. Present capacity indicates units included in current stage of development.

UC Under construction.

NA Information not available.



THE WORLD'S 20 LARGEST EARTH AND ROCKFILL DAMS

<u>Name</u>	<u>Volume Cubic Yards</u>	<u>Year</u>
<u>FORT PECK, U.S.A.</u>	125,600,000	1940
<u>OAHE, U.S.A.</u>	92,000,000	UC
<u>OROVILLE, U.S.A.</u>	78,000,000	UC
Mangla, Pakistan	75,000,000	UC
<u>SAN LUIS, U.S.A.</u>	75,000,000	UC
<u>GARRISON, U.S.A.</u>	66,500,000	1960
Portage Mountain, Canada	65,000,000	UC
NUREK, U.S.S.R.	58,860,000	UC
KIEV, U.S.S.R.	58,813,000	UC
Aswan High Dam, Egypt	53,000,000	UC
<u>FORT RANDALL, U.S.A.</u>	50,200,000	1956
KAKHOUKA, U.S.S.R.	46,617,000	1955
South Saskatchewan, Canada	45,000,000	UC
TSIMLYANSKAJA, U.S.S.R.	44,323,000	1952
KUIBYSHEV, U.S.S.R.	44,298,000	1955
KREMENCHUG, U.S.S.R.	36,281,000	1959
DNEPRODZERZHINSK, U.S.S.R.	35,965,000	UC
VOLGOGRAD, U.S.S.R.	33,000,000	1958
<u>KINGSLEY, U.S.A.</u>	32,000,000	1942
<u>TRINITY, U.S.A.</u>	29,000,000	1962

UC Under construction.

THE WORLD'S 20 LARGEST RESERVOIRS

<u>Name</u>	<u>Capacity, Acre-feet</u>	<u>Year</u>
Owens Falls, Uganda	169,500,000*	1953
Kariba, Rhodesia	149,000,000	1960
BRATSK, U.S.S.R.	145,000,000	UC
Aksombo, Ghana	120,000,000	UC
Manicouagan No. 5, Canada	115,000,000	UC
Aswan High Dam, Egypt	104,000,000	UC
Portage Mountain, Canada	88,000,000	UC
KRASNOYARSK, U.S.S.R.	59,400,000	UC
Sanmen Gorge, China	52,600,000	UC
KUIBYSHEV, U.S.S.R.	47,000,000	1955
Mangla, Pakistan	45,000,000	UC
BUKHTARMINSK, U.S.S.R.	43,000,000	1960
IRKUTSK, U.S.S.R.	37,300,000*	1956
Wainganga, India	33,200,000	UC
HOOVER, U.S.A.	31,047,000	1936
GLEN CANYON, U.S.A.	28,040,000	UC
VOLGOGRAD, U.S.S.R.	27,159,000	1958
El Fuerte, Mexico	25,000,000	1940
GARRISON, U.S.A.	24,500,000	1960
Lake Ontario, Canada/U.S.A.	24,288,000*	1958

\* Additional storage as result of dam construction.  
 UC Under construction.

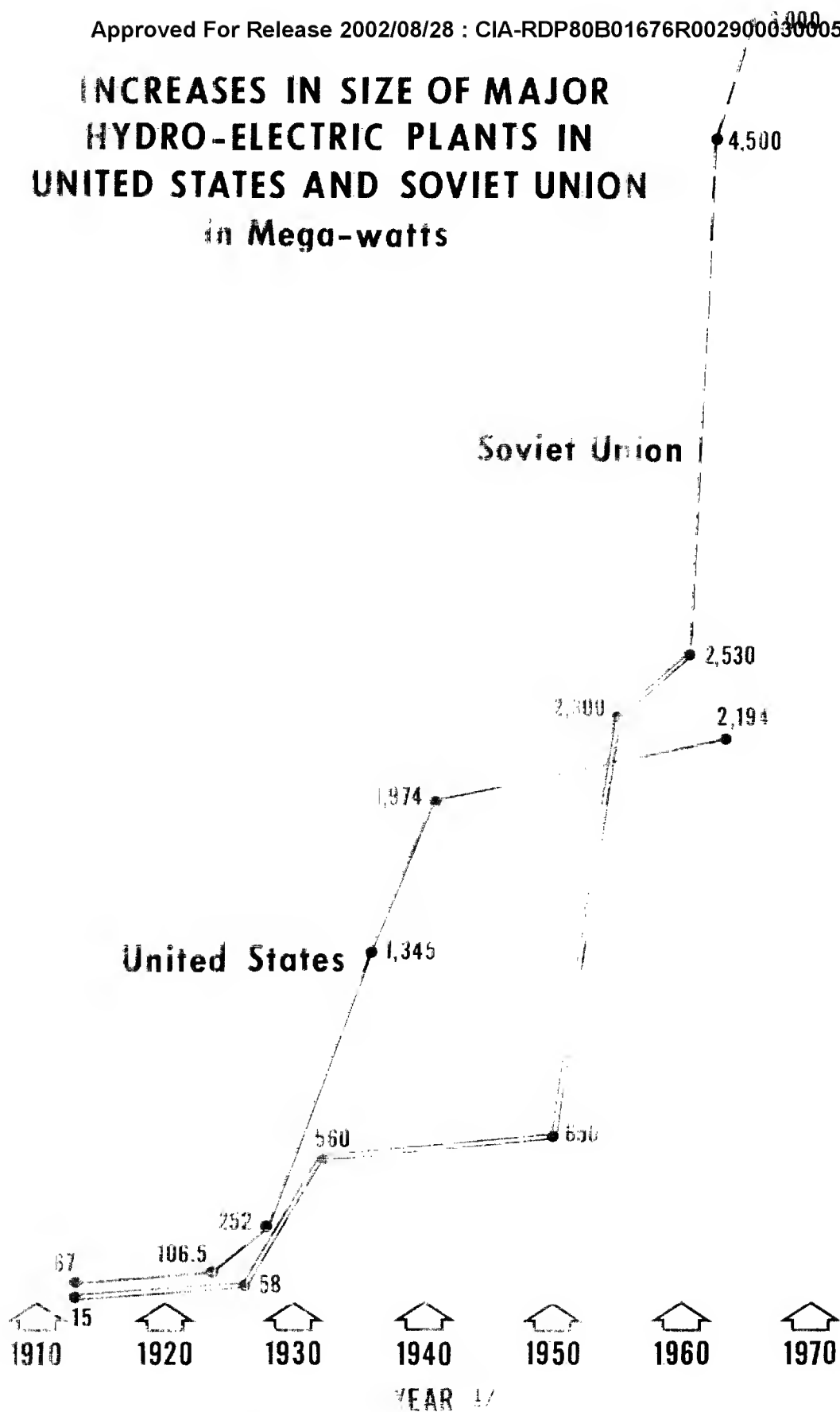
PART V. POWER GROWTH--U.S.S.R. AND UNITED STATES

The following charts, based upon material given the United States group while in Russia and upon statistics and other information compiled from United States sources, present graphically present and forecast power capabilities in the United States and the Soviet Union.

The first paired charts compared the growth in the size of hydroplants and generating units in Russia and the United States over the past half century. The massive growth in Russia began as soon as that country could recover after World War II and has proceeded at a rapid pace ever since.

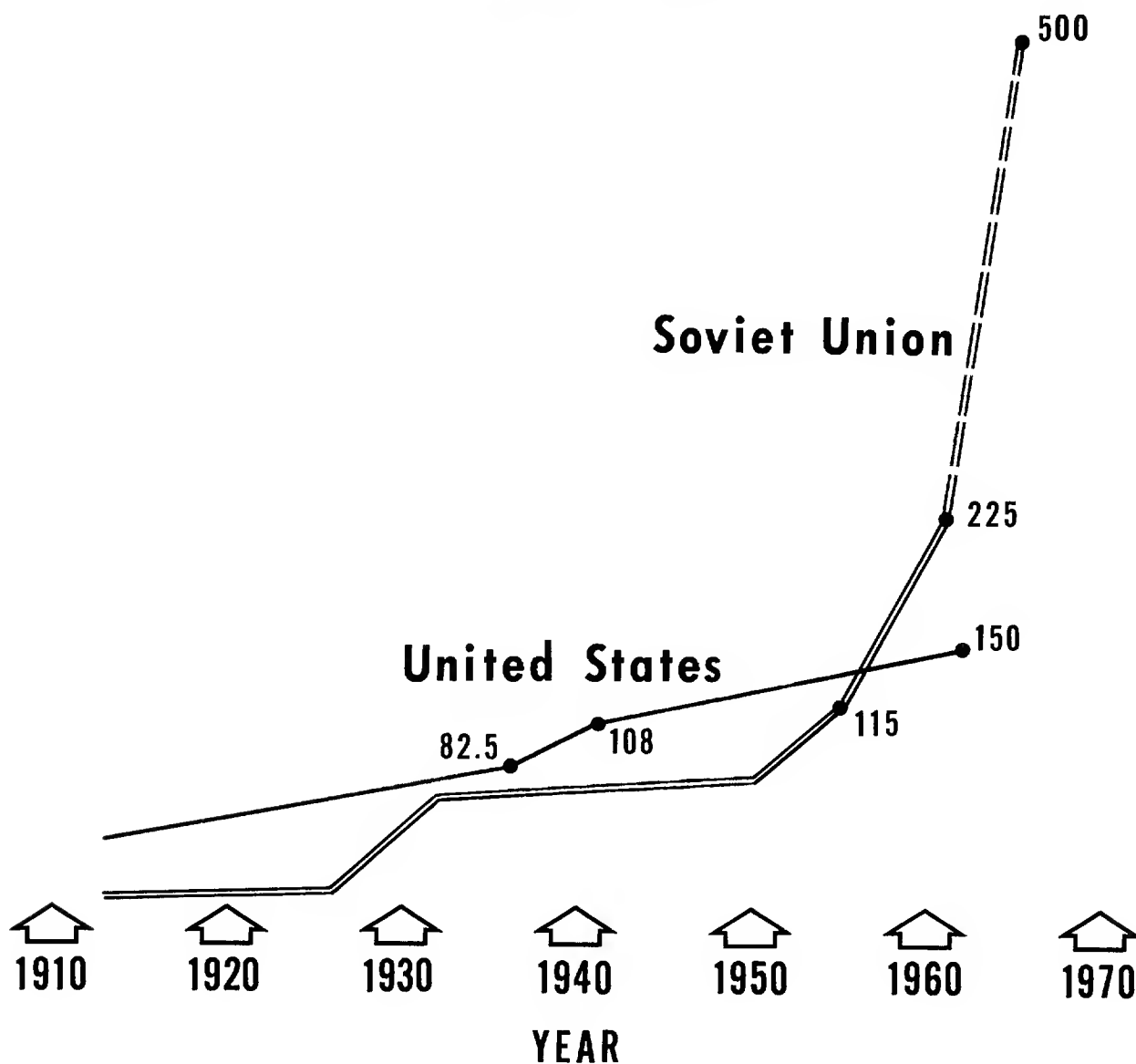
The next chart compares the increase in use of electricity in the two countries, and a companion chart shows the same information plotted on what is known as ratio paper. Use of this kind of plotting paper permits direct comparison of rates of growth as contrasted with absolute amounts. As measured by the per capita use of total energy, the Soviet Union is at the stage of its economic development that the United States was (as mentioned earlier) about 1900. Thus, although at the present energy use is expanding faster in the Soviet Union than in the United States, the rate of increase in the two countries during comparable stages in their economic growth was the faster in the United States, as indicated in the side box on the chart. Installed capacity shows the same story, since consumption is equal to capacity times a fairly constant plant factor.

# INCREASES IN SIZE OF MAJOR HYDRO-ELECTRIC PLANTS IN UNITED STATES AND SOVIET UNION in Mega-watts



// initial operation

## INCREASES IN SIZE OF HYDROELECTRIC POWERPLANT GENERATING UNITS In Mega-watts



Source of U.S. Data - Federal Power Commission

Figure 32

## CONSUMPTION OF ELECTRIC ENERGY UNITED STATES AND SOVIET UNION

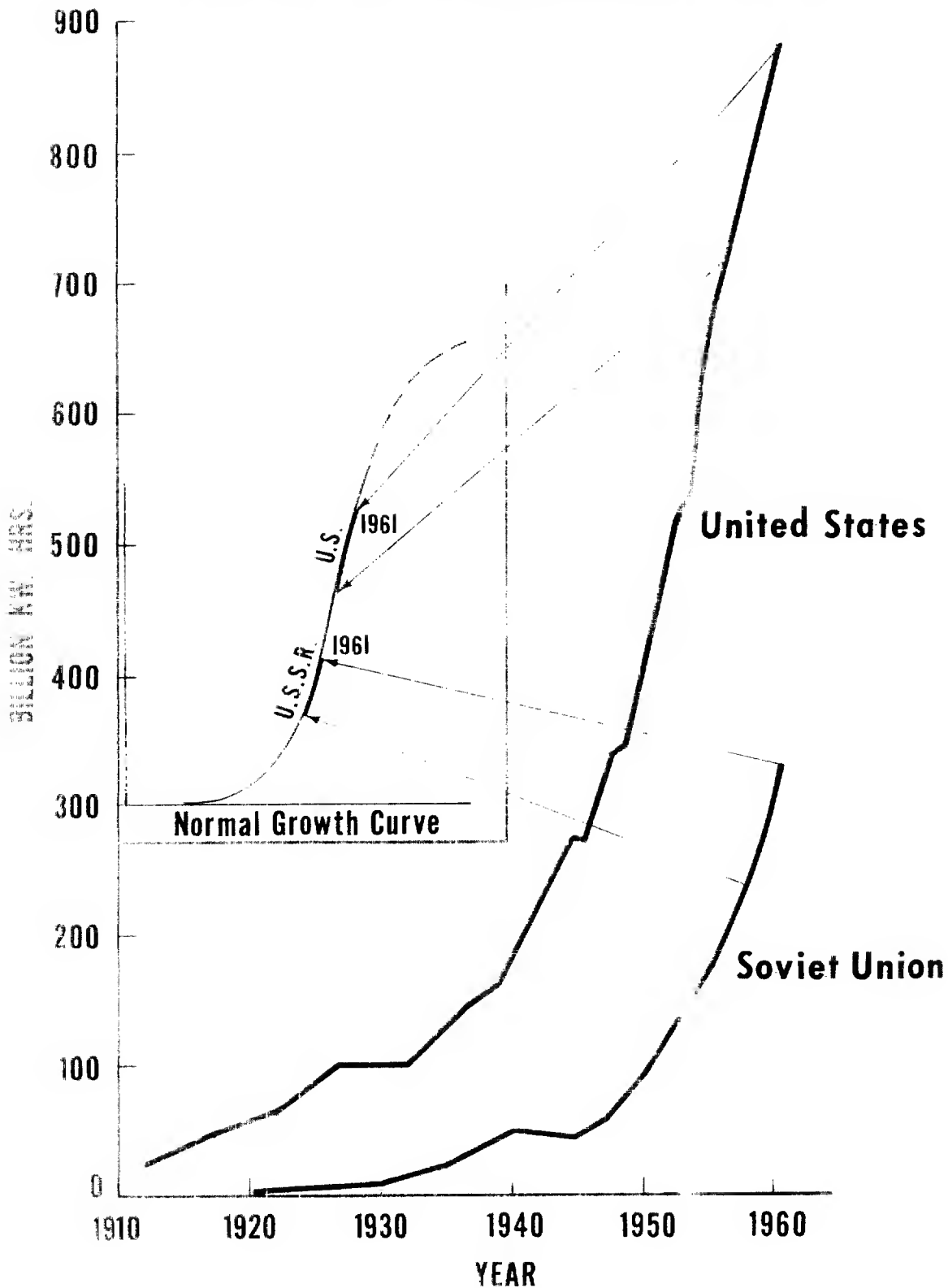
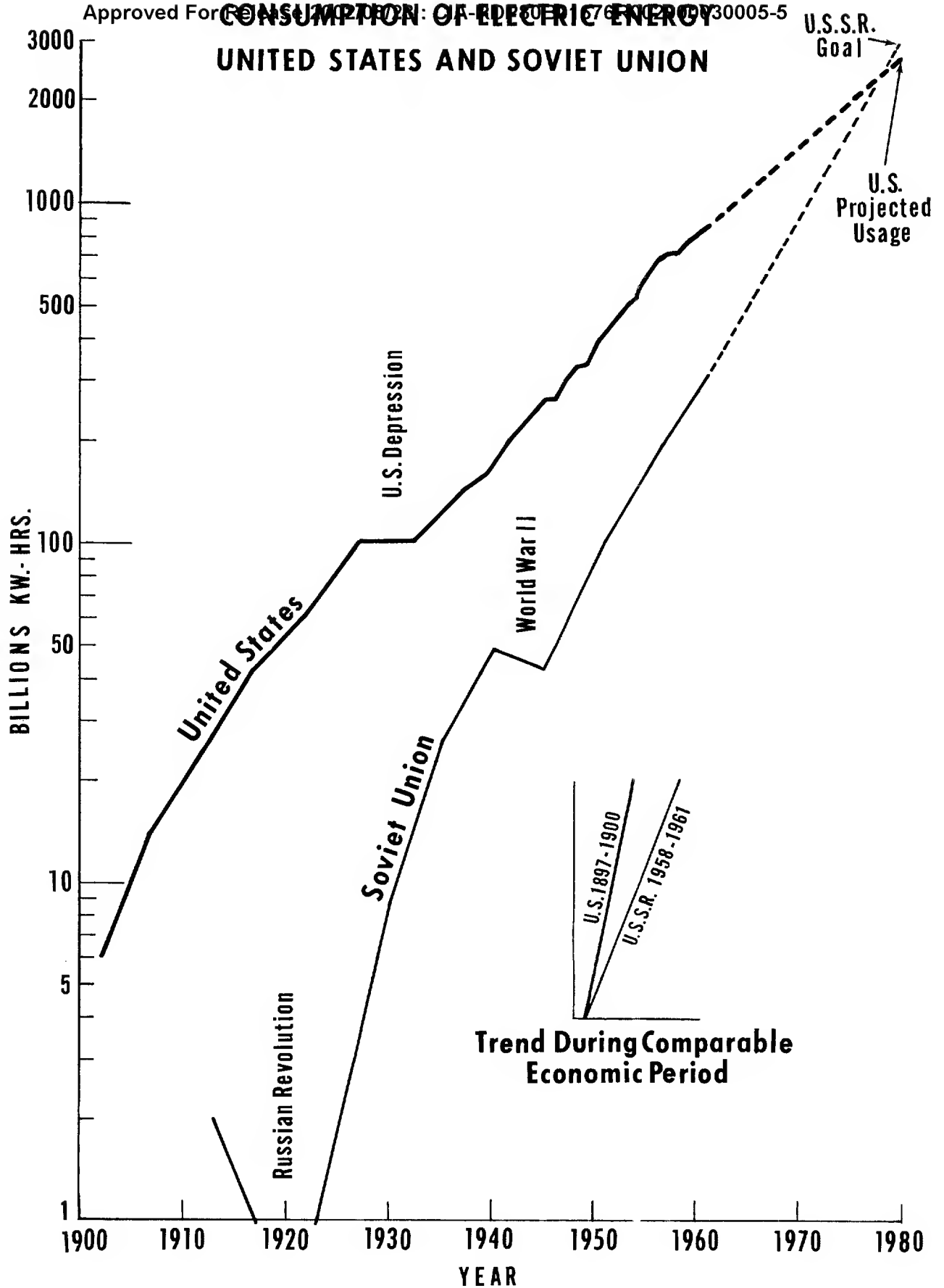


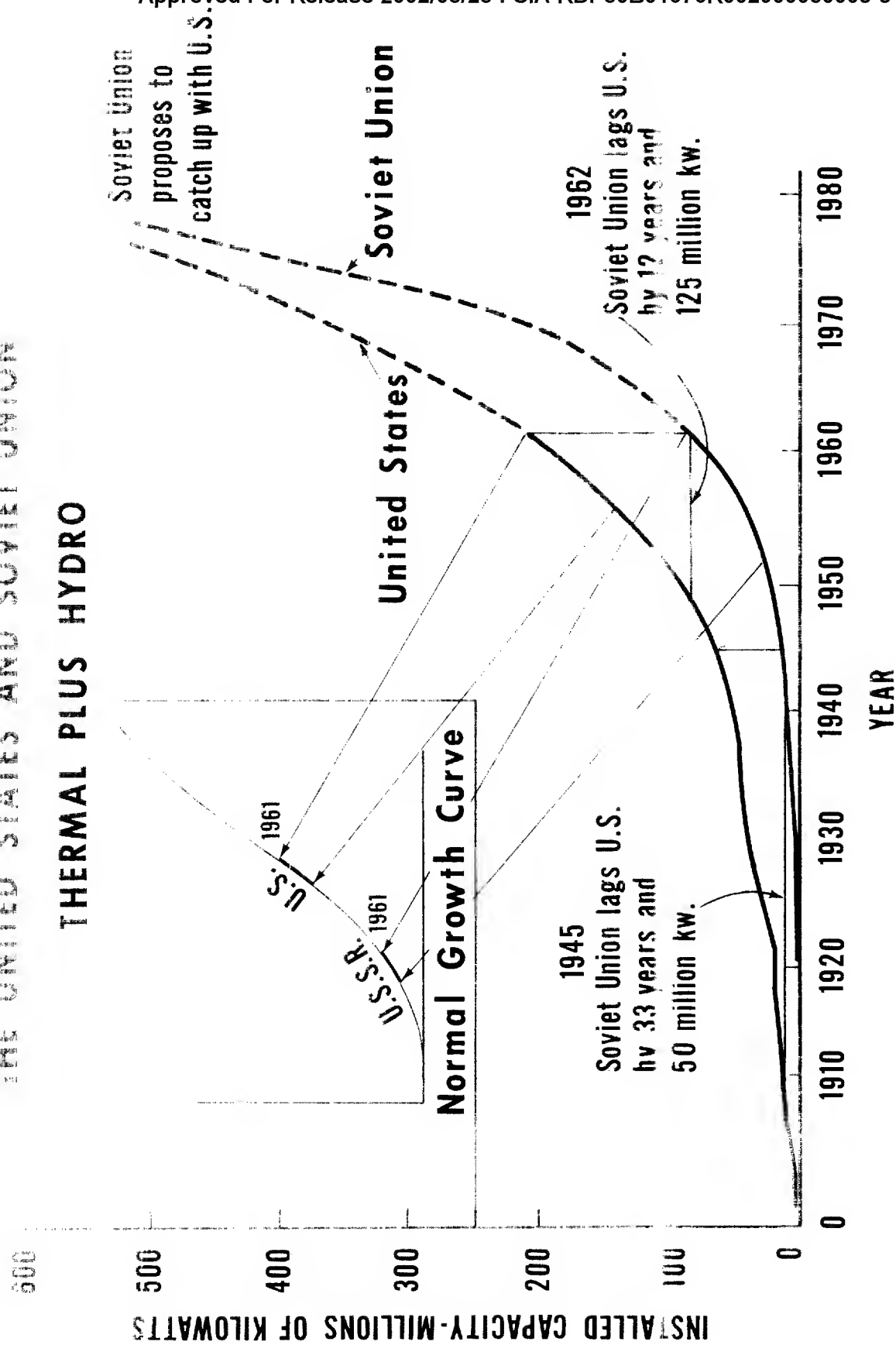
Figure 33



Source of U.S. Data - Federal Power Commission

# ELECTRIC POWER GENERATING CAPACITY IN THE UNITED STATES AND SOVIET UNION

## THERMAL PLUS HYDRO



Source of U.S. Data - Federal Power Commission

Figure 35



In any normal growth situation, the growth starts gently, gains speed, and eventually begins to slow down. Depicted graphically, the course of growth follows the form of the letter S, as shown in the inserts on the charts for installed capacity and consumption of electric energy. Rate of growth, however, progressively deteriorates, as shown by the chart on ratio paper.

The inserts in the figures show where the U.S.S.R. now is in the growth pattern as compared with the United States. In 1945, the Soviet Union lagged behind the United States by 33 years and 50 million kilowatts of installed capacity; by 1961, it lagged only 12 years in time, but the lag in capacity had grown to 125 million kilowatts. The capacity lag is certain to get larger before it gets smaller. The time figures point toward one interpretation, the capacity figures toward another. But such relationships, and the fact that in the Soviet Union the use of electricity according to figures given to the delegation is currently growing almost three times as fast as in the United States, have no absolute meaning; they take on significance only in relation to the relative stages of growth, one country in relation to the other.

Tabulations under the heading "Electric Power Generation and Consumption," show that the United States is presently at a much higher level than the Soviet Union in both generating capacity and production of electric energy. However, the annual installation of new capacity in the United States is on a plateau with even some tendency towards a reduction. The Soviet Union, on the other hand, is increasing rapidly with no tendency whatever towards flattening to a plateau.

Installation of new capacity in the United States dropped from 13.7 million kilowatts in 1959 to 12 million kilowatts predicted in 1962. This prediction is subject to slippage, the final figure may well range from 11 to 11.5 million kilowatts. The Soviet Union in the same interval of time, however, has risen from 5.7 million kilowatts to 10 million kilowatts, annually. Admittedly, the 10 million kilowatts is a planned figure given to us by Soviet officials, but on the basis of past performance it would not be surprising if this is actually achieved in 1962.

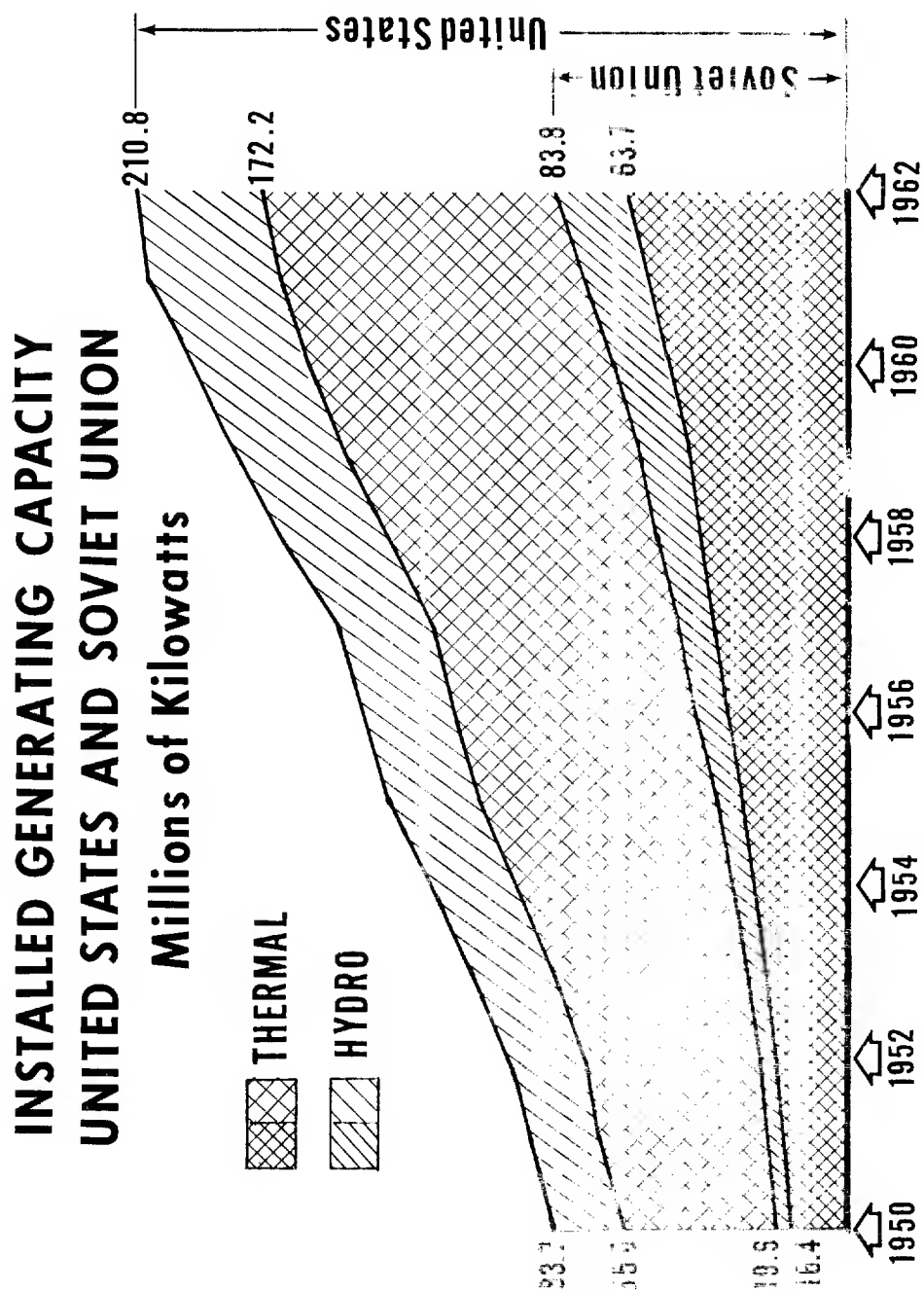
## ELECTRIC POWER GENERATION &amp; CONSUMPTION

<u>GENERATING CAPACITY</u>			<u>CONSUMPTION OF ENERGY</u>		
	<u>Millions of Kilowatts</u>			<u>Billions of Kilowatt-Hours</u>	
	<u>U.S.</u>	<u>U.S.S.R.</u>		<u>U.S.</u>	<u>U.S.S.R.</u>
1958	161.5	53.6	1958	225.7	235.4
1959	175.2	59.3	1959	296.4	265.1
1960	186.6	66.7	1960	342.1	292.3
1961	198.8	73.8	1961	360.0	327.0
1962	210.8 (est.)	83.8 (Plan) 27	1962	412.0 (est.)	366.0 (Plan)

<u>CAPACITY ADDITIONS</u>			<u>ENERGY INCREASES</u>		
	<u>Millions of Kilowatts</u>			<u>Billions of Kilowatt-Hours</u>	
	<u>U.S.</u>	<u>U.S.S.R.</u>		<u>U.S.</u>	<u>U.S.S.R.</u>
1959	13.7	5.7	1959	70.7	29.7
1960	11.4	7.4	1960	48.7	27.2
1961	12.2	7.1	1961	32.1	34.7
1962	12.0 (1)	10.0 (Plan) 27	1962	64.3	39.0 (Plan)

1/ Possibility of slippage to 11.5 or 11.0

27 Data furnished to U.S. delegation by Soviet officials



Source of U.S. Data - Federal Power Commission

Figure 36

PART VI. SOVIET AND UNITED STATES GOALS

The Soviet Union

In a speech before the 22nd Congress of the Communist Party in October 1961, Chairman Khrushchev reported that high priority was being placed on electrification of the country. The plan calls for 520 billion kilowatt-hours by 1965, 950 billion by 1970, and between 2,700 billion and 3,000 billion by 1980. The 1980 goal is almost ten times the 1961 output of 327 billion kilowatt-hours.

In a speech in November 1959 to the All-Union Conference of Power Industry Construction, Chairman Khrushchev had placed the 1980 target at 2,300 billion kilowatt-hours, so the Russians appear to have raised their sights. We are tempted to believe that the Soviets did so to keep pace with America's own rising estimates for 1980, while adhering to their intention of equaling or surpassing this Nation by then. At the time of the 1959 speech, U. S. forecasts for 1980 projected to about 2,300 billion kilowatt-hours; by the time of the 1961 speech, there were half a dozen forecasts in the range of 2,760 billion to 2,990 billion. (See paragraphs following.)

Expansion in the U.S.S.R. will be in both hydroelectric and thermal power stations. It had been the Soviet plan to emphasize the construction of hydroplants, because such power is cheaper; but in the 1959 speech, Chairman Khrushchev explained a change in this policy toward whatever combination of hydroplants and steamplants would get the country electrified the fastest--would get it electrified within the 1975-1980 period.

"When you tell me," he said to his audience, "that you can produce a kilowatt-hour of power from a hydropower station, but you will get it five years later than its thermal ... counterpart ... that is worth thinking about, because we can lose five years in our competition with capitalist countries."

During Secretary Udall's meeting with Chairman Khrushchev September 6, 1962, at Cape Pitsunda on the Black Sea, the Soviet leader remarked to Secretary Udall that Russia has challenged the United States to an energy race.

As explained by Secretary Udall September 11, 1962, at a press conference in the United States:

"With regard to the effort they are making in what Chairman Khrushchev called the energy race, the race to see which country can produce the most energy to drive its industrial machine, with the advanced work that they are doing, particularly in the field of hydroelectric power, I would say in the thermal power field we are leading in most aspects of this field, but over the past 10 years or so the Soviet Union people obviously have developed a very high degree of competence and our engineers respected it, and this means that we have a formidable challenger in this important field.

"As I told Mr. Khrushchev ... he said they were challenging us to an energy race, they were going to overtake us ... that we welcomed a contest of this kind. I thought that we had the men and the system in this country to meet such a challenge."

POWERPLANTS IN THE USSR WITH A  
CAPACITY OF 1,000 MEGAWATTS OR OVER  
TO BE IN OPERATION BY END 1965

UNDER CONSTRUCTION    IN OPERATION  
THERMAL    ●    ■  
HYDRO    ○    □

Figure 37

By 1980, the Soviet Union plans to have in operation 180 large, new hydroelectric stations, about 200 regional thermal plants, and another 260 thermal plants for both power and heat. After the completion of the Bratsk and Krasnoyarsk hydroelectric stations, the plan for eastern Siberia calls for the construction of several more large hydroelectric stations on the Angara and Yenisey Rivers (at Sayanskaya, Ust-Ilim, Boguchany, Yeniseisk and Osinovo) as well as a station on the Lower Tunguska River. The capacity of each of these is to exceed four million kilowatts.

Large dams are to be built in Central Asia for both power generation and irrigation. Among these are the Nurek and Rogunskaya dams on the Vakhsh River and the Toktogul and Toguztorouskaya dams on the Naryn River. Several large powerplants will be built in Kazakh-stan, including the Irtysh group. The Volga-Kama power chain is to be completed with the construction of the Saratov, Lower Volga, and Cheboksary stations and two stations on the Kama. Hydro output along the Volga and Dnieper Rivers will be almost doubled.

Two groups of thermal powerplants are to be built in Moscow, each having a capacity of three million kilowatts, and several in the vicinity of Saratov, Volgograd, and Gorky and in the Kuibyshev Ufa-Orenburg area, as well as in the regions south and northeast of Moscow, in the Ukraine near Kiev, Kirovograd, and Nikolayev, and in the Donets Basin, Latvia and Belorussia.

For the Soviet Union to meet its goals, it will be necessary for them to place in operation, on average, one plant of the size they

are talking about, be it hydroelectric or steam, every two weeks between 1965 and 1970, and one every week after that--and they appreciate this.

#### The United States

The foregoing comments refer to plans--to goals that the Soviet Union is determined to reach. The United States does not have such goals. Numerous forecasts have been made regarding our future use of power, but they are no more than that; that is no more than forecasts of what the United States is expected to be using under the normal course of national growth. Far from representing targets or goals, they specifically assume no basic change in public policy. Each person making such forecasts or projections makes his own calculations or assumptions about population, economic growth, business swings, the way in which the energy is going to be used, and similar considerations. As a result, and even though all are recognized authorities, their projections range widely. Estimates of the 1980 use of all kinds of energy in the United States range from 73,250 trillion Btu's (British thermal units) to fully 145,000 trillion Btu's: i.e., the highest estimate is twice the lowest. In electric generation, recent estimates are more nearly uniform, ranging from 2,300 billion kilowatt-hours in 1980 to 2,990 billion kilowatt-hours. But in hydropower, the highest also is twice the lowest--300 billion kilowatt-hours as compared to 145 billion kilowatt-hours. A recent report made for the United States Senate Committee on Interior and



Insular Affairs 1/ deduced a consensus, from among these various estimates, of 82 trillion Btu's of total energy, 2,700 billion kilowatt-hours of electric energy, and perhaps about 275 billion kilowatt-hours of hydropower. Thus, in 1980 the use of energy of all kinds in the United States is forecast as being about double that of 1961, use of electric energy about 3-1/2 times the 1961 usage, and hydropower about 1-3/4 times. Hydropower is expected to drop from 17.5 percent of total electric generation to as low as 10 percent.

The United States, too, has a number of hydroplants under construction: the Wanapum (Washington), Oroville (California), Trinity (California), Oahe (South Dakota), Glen Canyon (Arizona), and Yellowtail (Montana) plants.

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1/ Report of the National Fuels and Energy Study Group on an assessment of available information on energy in the United States. 87th Congress, 2nd Session. September 21, 1962.

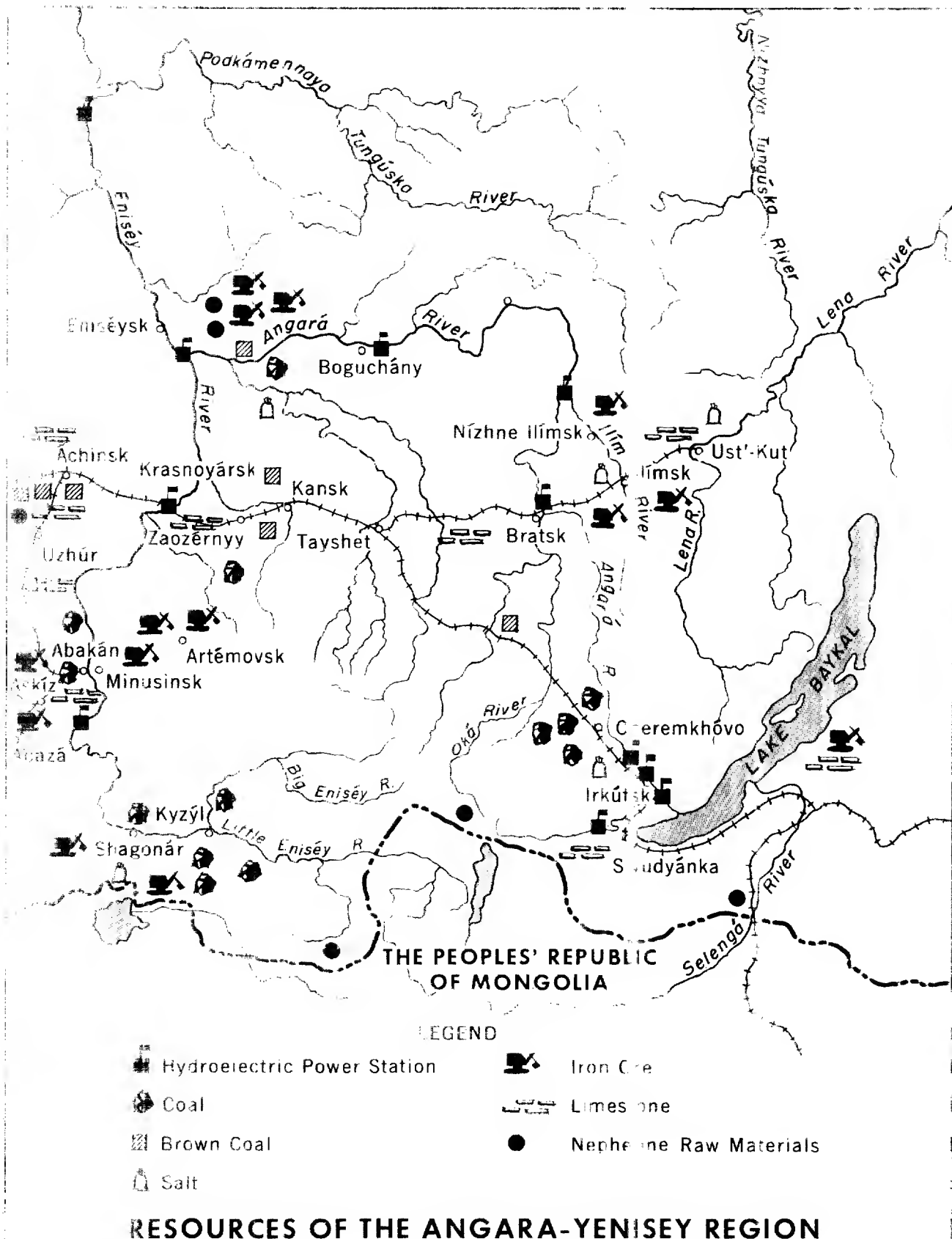


Figure 38

## PART VII. RAW MATERIAL RESOURCES

In this portion of the report, the basic energy resources of the United States and Russia are examined.

Generation of electricity is made possible by utilizing a wide range of materials and conditions, the traditional and most popular ones being coal, oil, natural gas, and falling water. In addition, nuclear fuels have made their appearance. Less important to the United States in the energy field, at the moment, are wood, oil shale, and peat. These three, however, provide a considerable portion of Russia's energy.

The energy resource figures given for the United States are those made by our own American experts. The basis for them is known, as well as the estimated margins of error. The figures for the Soviet Union come from various sources, as noted, including information given the United States group in its 1962 trip; the delegates do not know the criteria on which they are based and, therefore, do not know if they can be compared directly with those of the United States. Yet, they are the only ones available, and the group is forced to take them, while recognizing that comparisons have generalized meaning only.

Electric energy and the source fuels compete with one another for some purposes. For example, electricity, coal, oil, and gas all are used for space heating and in industrial processes; and electricity and oil are used for railroad motive power. Examination of these

resources has thus a double value. The varied use of each, however, is related as much, or more, to the culture and geography of the U.S.S.R. and the United States as to their stage of economic strength; and these aspects of the "energy race" (or "electricity race") are discussed elsewhere in this presentation.

### Falling Water

In the field of energy, falling water is synonymous with hydropower potential. The total hydropower potential of the Soviet Union is about 465 million kilowatts; ours is 147 million kilowatts. These are equivalent to a generation of about 2,100 billion kilowatt-hours in the Soviet Union and 643 billion kilowatt-hours in the United States. The United States already has developed 25 percent of its hydropower potential, the Soviet Union only three percent. This means that the Soviet Union still has well over 400 million kilowatts of hydropower capacity upon which to work, while the United States has only 114 million kilowatts.

The Soviet Union has seven great rivers, several of which have more hydropower potential than our most powerful -- the Columbia River. (Our largest river is, of course, the Mississippi, but the Columbia River has the greatest hydropower potential.) These seven Soviet rivers are the Ob, Irtysh, Yenisey, Angara, Vitim, Amur, and the Lena, all in Siberia and traversing the full width of the country from China-Mongolia border to the Arctic Ocean.

No less than 80 percent of the U.S.S.R. undeveloped water power is estimated to be in this region, and this has been said by some

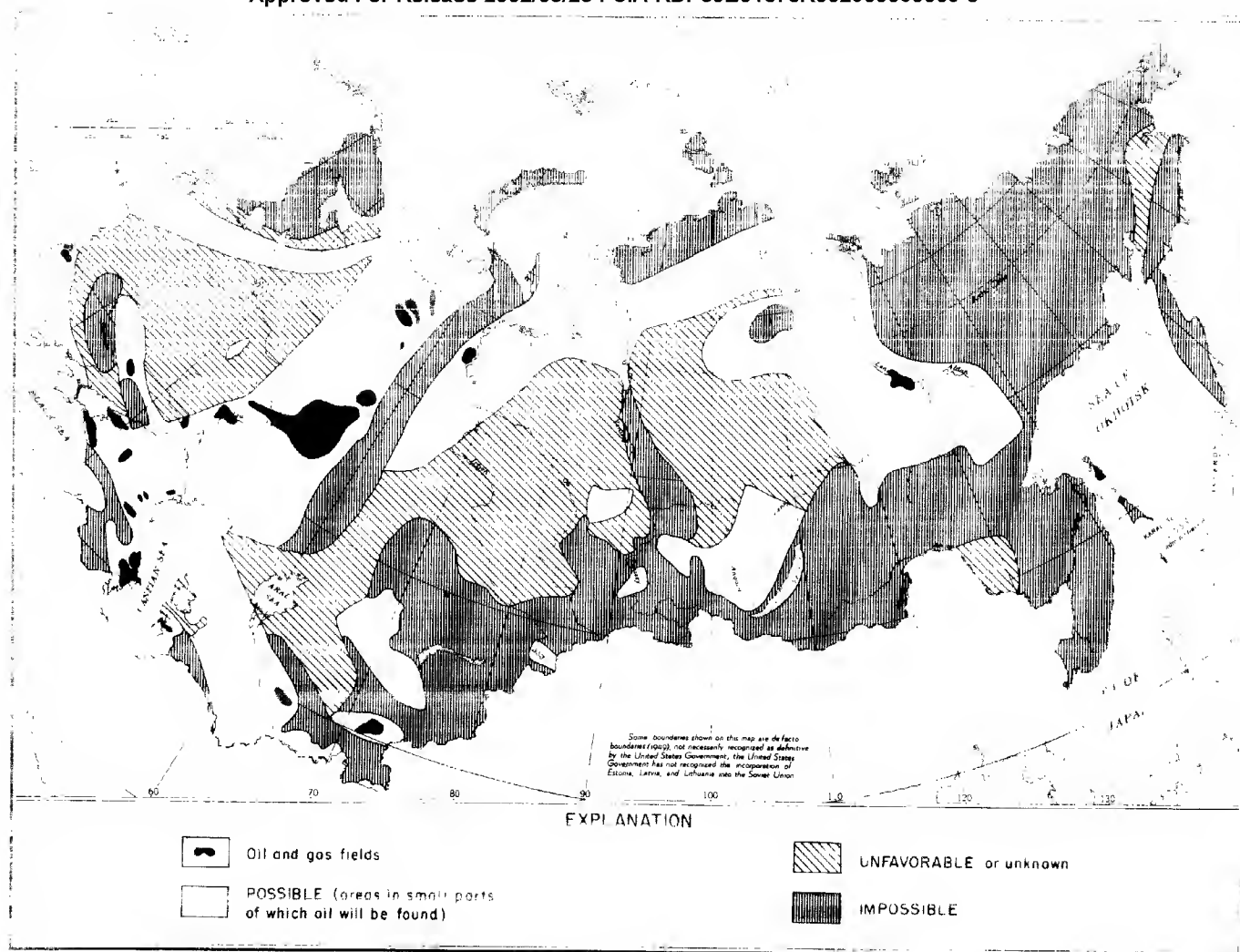
commentators to be a reason why the American group should not place much significance upon the comparisons given above, because the region is so remote and thinly populated. This report will comment on that point in a later chapter.

### Oil

Proved reserves of petroleum and natural gas liquids in the United States on December 31, 1960, totaled 39 billion barrels. Petroleum engineers judge this figure to be accurate within ten percent, and the margin of error is probably on the plus side; i.e., the figure is probably low because engineering estimates tend to be conservative.

Estimates of reserves of petroleum in the Soviet Union are sketchy, uncertain, and contradictory. Reasoning from Soviet references to the relation between reserves and rate of production, a 1960 United States delegation of petroleum engineers to the Soviet Union estimated U.S.S.R. reserves at the end of that year to be 24 billion barrels. Other estimates place the reserves at 34 billion barrels. These figures do not include natural gas liquids, but the exclusion does not matter here, because the amount is swallowed in the uncertainty engendered by this wide range. Eight-tenths are in the Urals-Volga region.

The foregoing figures are for proved reserves. That means oil (a) whose presence is known with some assurance and (b) that can be recovered under existing conditions of cost and sales price--under



OIL AND GAS FIELDS OF THE SOVIET UNION

Figure 39

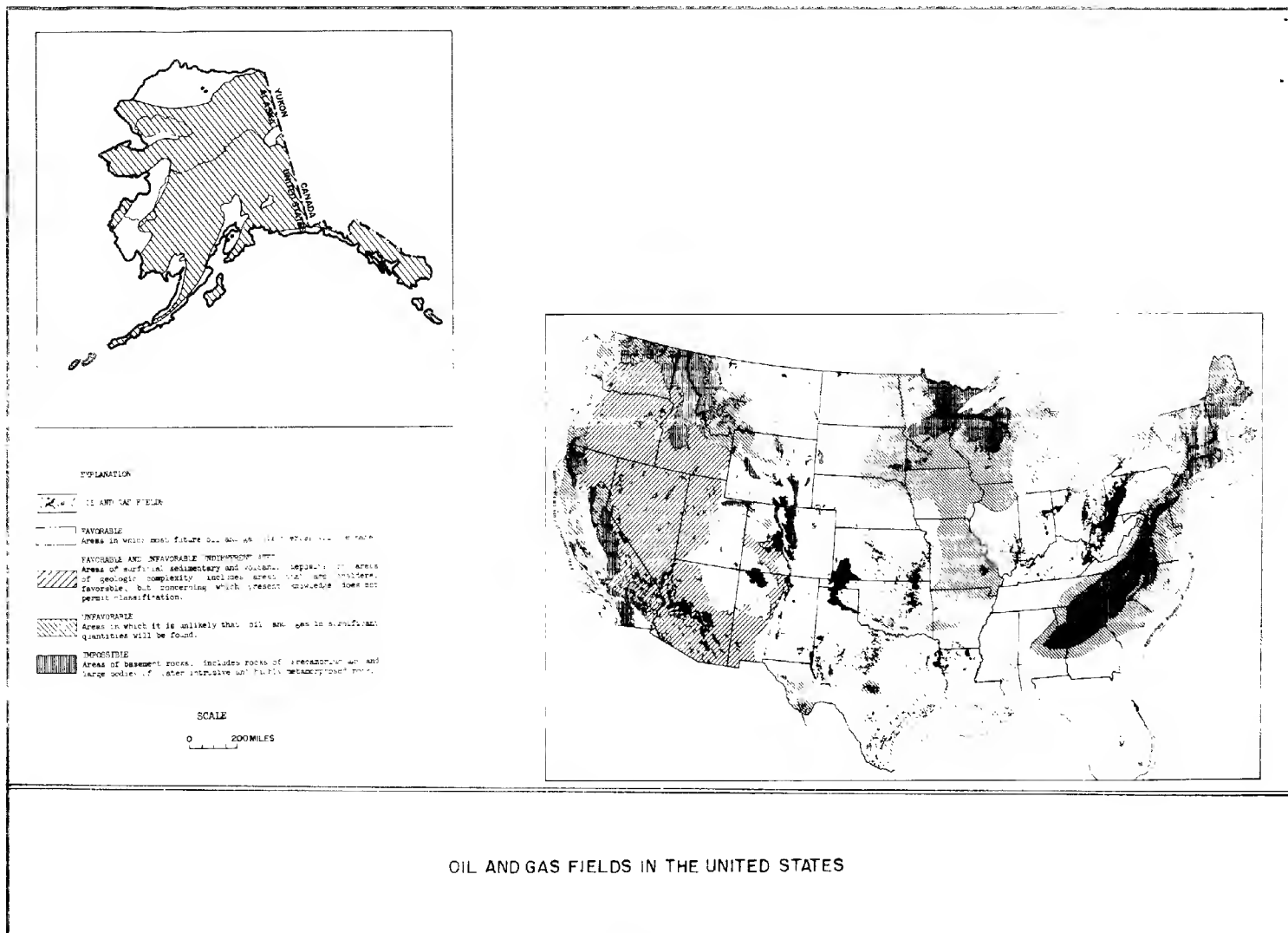


Figure 40

existing conditions, to repeat, not under conditions that may exist at some future time. The degree of assurance is noted above. The stocks of both countries contain many more times those amounts. The totals are, of course, speculative, because no one can look into the ground to measure what is there, but American engineers and geologists guess that the figure for the United States is in the neighborhood of 300 billion barrels. The corresponding guess for the Soviet Union is perhaps 100 billion barrels, but this figure is particularly dubious. In degree of petroleum exploration, the Soviet Union now stands where the United States stood in 1930; continued major discoveries in Russia are almost certain, and the quantity eventually discovered could be as much as ten times or more the 100 billion barrels stated.

#### Natural Gas

Proved reserves of natural gas in the United States total 268 trillion cubic feet, with another 1,000 to 2,000 trillion cubic feet conjectured as remaining to be found. The Soviet Union was reported at the 1962 World Power Conference Survey to have 70 trillion cubic feet of reserves, and some American experts conjecture that between 100 and 3,500 trillion cubic feet remain to be discovered, others place the figures at 500 to 1,500.

The estimate of United States reserves is judged to be accurate, like the estimate of oil reserves, within ten percent. The estimate of Soviet reserves probably has a margin of error even greater than that noted for oil. The figures for potential discoveries are equally



speculative for the two countries. To now, gas has found so little use in the U.S.S.R. that there has been little incentive to estimate either proved reserves or ultimate potential, and it is really difficult to know what value to place on the figures given. Perhaps all the figures mean is that, in present opinion, energy supply in the Soviet Union in the form of natural gas is about the same as in the United States.

#### Coal

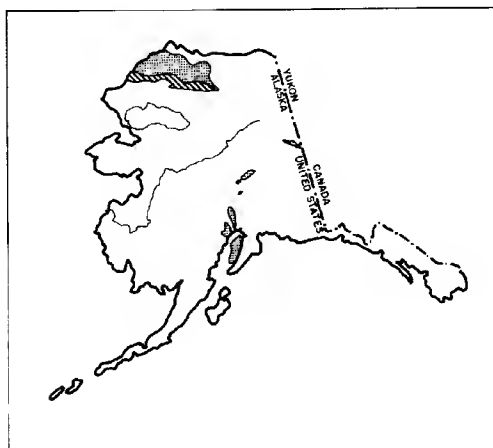
Reserves of coal in the United States, estimated under the same criteria as proved reserves of oil and gas, total about 20 billion tons. At current costs and at sales prices about 25 cents a ton higher than at present, they would total about 35 billion tons. An additional 800 billion tons is judged to be present in the ground and to be recoverable under suitable economic conditions.

Reserves of coal in the Soviet Union are judged to be about 30 billion tons. This figure is derived by taking figures on all the coal in the ground as put together by students of Soviet resources; then assuming that Russian coal seams have the same proportions of thick and thin layers as do United States seams, in order to obtain a figure for total coal ultimately recoverable; and then further assuming that the ratio of reserves to the total is similar to what it is in the United States. The total of U.S.S.R. coal ultimately recoverable is judged to be 1,300 billion tons.



COAL-BEARING BASINS AND DEPOSITS OF THE SOVIET UNION

Figure 41

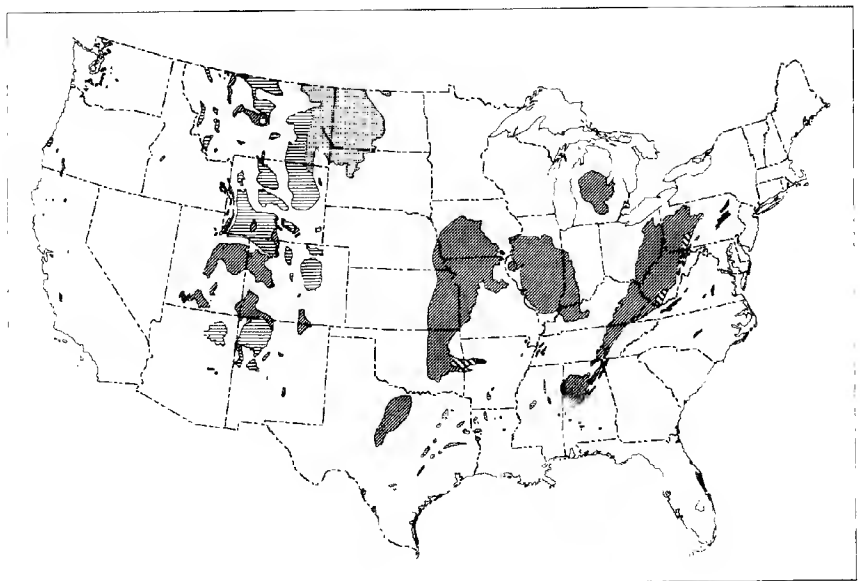


EXPLANATION

- Anthracite and semianthracite
- ▨ Low-volatile bituminous coal
- ▩ Medium- and high-volatile bituminous coal
- ▬ Subbituminous coal
- ░ Lignite

SCALE

0 200 MILES



COAL FIELDS OF THE UNITED STATES

Figure 42

#### Nuclear Power

Reserves of uranium in the United States are equivalent to between 10 billion tons and 500 billion tons of coal, depending on the efficiency of atomic reactors. At higher prices per unit of uranium oxide, the reserves would be the equivalent of between 200 billion tons and 10,000 billion tons of coal. The figures are so large as to be difficult to grasp.

Few figures are available on the delicate subject of reserves of uranium in the U.S.S.R. The coal equivalent is calculated at 3 billion to 4 billion tons, which compares with our 10 billion tons, but the figures could be much greater.

#### Wood, Peat, and Oil Shale

Wood still provides two percent of the total energy used in the United States, under special sorts of conditions, as in fireplaces and locally under saw-mill boilers.

Peat is not used as a fuel in the United States, nor is such use contemplated. Oil shale has received considerable attention, but there is no production, its use still being considered economically marginal. Our deposits contain between 50 billion barrels of oil and something more than 500 billion barrels, depending on the price we are willing to pay for it.

In the Soviet Union, however, all three of these fuels are employed and in 1961 provided about a twelfth of all energy used.

Total Reserves

The total reserves of energy raw materials as presently known and usable in the two countries, including hydropower potential in that category, sum up as shown below. In calculating the kilowatt-hour equivalents, a heat-rate of 10,500 Btu's per kilowatt-hour was used, which was the United States average in 1961.

	<u>Energy Reserves</u>		<u>Kilowatt-hour</u>	
	<u>Volume</u>		<u>Equivalent (trillion)</u>	
	<u>U.S.S.R.</u>	<u>U.S.</u>	<u>U.S.S.R.</u>	<u>U.S.</u>
Hydropower, kw-hrs.	2,100 billion	645 billion	2.1	0.6
Oil, bbls.	34 billion	39 billion	18.5	21.2
Gas, cu. ft.	77 trillion	268 trillion	8.1	28.2
Coal, tons	30 billion	20 billion	75.0	50.0
	<u>Totals (rounded)</u>		103.7	100.0

The grand totals come out about equal. Similar tabulation for total usable resources, discovered and undiscovered, developed and undeveloped, yields about 4,250 trillion kilowatt-hours equivalent for the Soviet Union and 2,500 trillion for the United States, the Soviet Union having the greater amount because of its larger hydro-power and coal resources.

Coal, oil, and gas are used in both countries, of course, for other purposes than the generation of electricity, as described in a subsequent chapter. The recent report of the National Fuels and Energy Study Group to the United States Senate concludes, however, that the United States can readily supply its total needs to

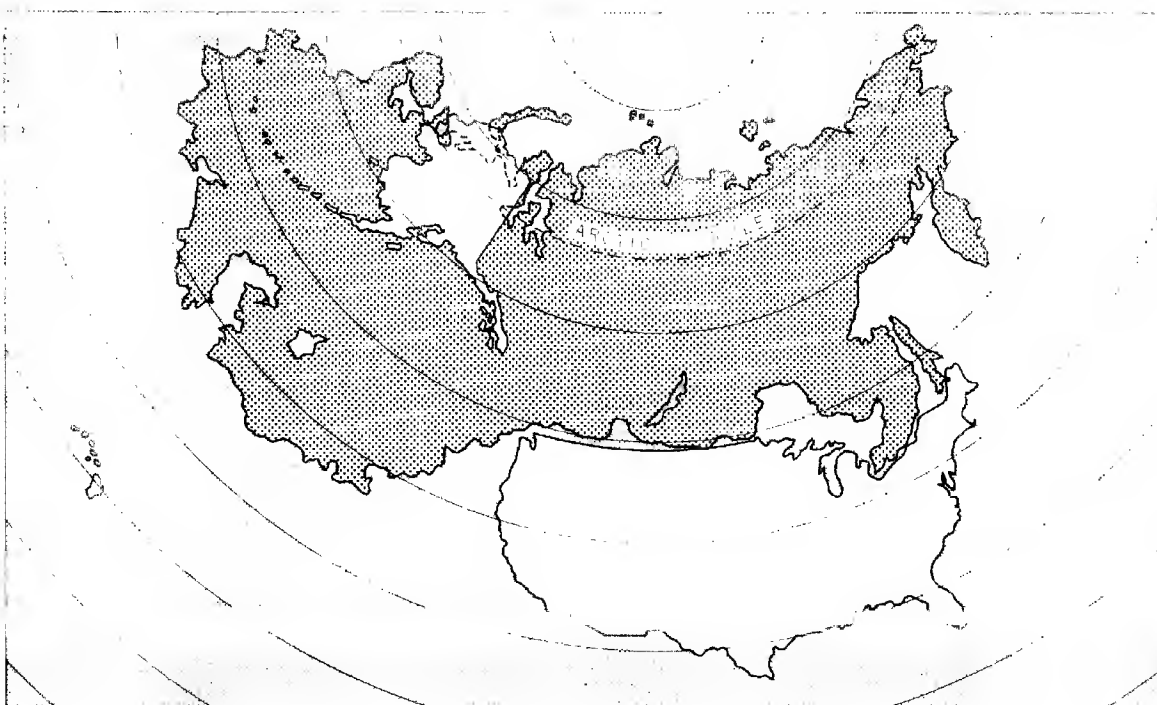
1980. The authors have no projection of expected total use of energy in the Soviet Union for that year, but Russia's nonelectric use of energy is less than in the United States, where we have large consumption of energy by the consumer, and the Soviet Union should experience even less trouble than the United States.

For many decades beyond 1980 both countries have such large potential that the limits of the resource base should be no drawback to either country.

PART VIII. SOVIET ECONOMIC GEOGRAPHY

Because the Soviet Union is so huge, it is easy to jump to the conclusion that her natural resources are equally immense and only slightly developed. Russia is three times as large as the main body of the United States, 2-1/2 times as large even including Alaska and Hawaii--ergo, her natural resources must be proportionately larger. In some respects that is correct. It has been noted, for example, that her hydropower resources are more than three times as large as the United States and that her coal resources seem about twice as large. We know she has large deposits of iron ore and manganese for the making of steel. In other aspects, however, the conclusion appears incorrect--current available evidence, admittedly sketchy and conjectural, suggests that her resources of oil and natural gas are about the same as ours. We are quite sure that the United States has more molybdenum, copper, borax, sulphur, potash, and phosphate. Some other countries surpass Russia in other raw commodities.

In still other directions, we are literally ignorant of what the Soviet Union has. True, the Soviet Union has three times the land area of the United States, but she does not therefore necessarily have three times the resources. Her geology is not the same as ours, and it is the nature, distribution, and history of rocks--not area--that control the presence or absence of a mineral deposit, the existence of large ore bodies or small ones, rich ones or lean ones, and, yes, water power. Siberia was a surprise. The visiting group had



U.S. and U.S.S.R. compared in size and latitude location. Only a fifth of the Soviet territory is in as favorable latitude as the U.S.

Figure 43



imagined Siberia to be a bleak, barren, and forbidding land, but it turned out to be a beautiful region of forests, lakes, rivers, and farm lands. Its greatest handicap is the climate, which provides a growing season of not much more than 60 days.

Only a fifth of the Soviet territory is in as temperate a latitude as the United States. Almost two-thirds lies between the latitudes of the Canadian border and the Arctic Circle, and a sixth lies north of the Circle. Not only does this affect the growing season for agriculture, it calls for extra effort and expense in the development of the mineral resources that may be present.

Because of these facts, some have doubts about the economic potential of Siberia, pointing out that 70 percent of Canadians live within 100 miles of the United States border, leaving the northlands relatively unsettled and undeveloped. They draw the conclusion that the same thing must happen in Russia. However, developments in technology that make it easier to live in reasonable comfort in Siberia, and settle and develop its resources, may mean a wider exploitation of resource potentials than heretofore thought possible.

## PART IX. SOVIET USES OF ENERGY

The Soviet Union and the United States being at different stages in their economic growth, the purposes for which energy is used are necessarily different. Soviet geography and Soviet culture contribute to an even greater degree to a different pattern of use. Being high in the northern latitudes, the country needs more heat. It being large, distances are great, and industrial centers are deliberately located with the problems of transportation of materials and labor in mind. The following tabulations compare the way in which fuels are used in the United States with the way they are allocated in the Soviet Union. The data for the United States are from Resources for the Future, Inc., tabulated in 1955, reassembled to correspond to the categories in which the Soviet data are available. The available Soviet data are for various years, as noted, and so individual components are not precisely comparable, but the relative dimensions of the use patterns seem clear.

PERCENTAGE FUEL CONSUMPTION BY CONSUMER CLASSES

	<u>Soviet Union</u>			
	<u>Coal (1958)</u>	<u>Oil (1959)</u>	<u>Gas (1960)</u>	<u>Total</u>
Industrial	)36.9	39.3	)83.3	
Agriculture	)	20.0	)	
Transportation	17.3	16.0	--	14.7
Residential	13.1	2.6	12.6	9.8
Electric generation (and heat from thermal power stations)	32.7	5.7	--	22.4
Other	--	16.4	4.1	3.9
	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>

	<u>United States (1955)</u>			
	<u>Coal</u>	<u>Oil</u>	<u>Gas</u>	<u>Total</u>
Industrial and Commercial	)51.7	20.2	)47.3	)50.1
Agriculture	)	3.5	)	)
Transportation	2.9	42.9	2.6	20.7
Residential	8.2	14.7	22.6	14.8
Electric generation	37.2	3.6	13.9	16.2
Government & misc.	--	15.1	13.6	10.2
	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>

The distribution of electric energy is as follows, the figures in all instances being for 1960:

	<u>U.S.S.R.</u>	<u>U.S.</u>
Industrial and commercial	65.2%	63.3%
Transportation	7.2*	0.6
Electric power stations, including losses in the system	12.4	8.4
Others <u>1/</u>	<u>15.2*</u>	<u>27.7</u>
	100.0	100.0

\* Approximations.

1/ U.S.: Irrigation, pumping, and other agricultural uses, residential, street and highway lighting, delivery to other consumers. U.S.S.R.: Illumination and everyday needs, water and sewer lines.

Specifically, industrial consumption in the Soviet Union in 1960 was 190.5 billion kilowatt-hours, in the United States 537.4 billion.

The outstanding characteristic of the Soviet economy is the high priority given to increasing industrial strength. Afflicted with a chronic shortage of capital, the Government appears to be allocating available capital with the single-minded purpose of developing a strong industrial complex. This must account for the concentration on thermal and hydroelectric energy and on the extra-high-voltage transmission lines needed to utilize this energy. In the United States, industrial, agricultural, and household usages have developed and are apportioned one with respect to the others by joint meshing of the plans of Government, industry, and the individual. Energy for the farms and households seemingly awaits the abatement of the Cold War and a new system of priorities that puts the needs of the individual first.

The Soviet Union's housing and transportation programs also demonstrate their determination to give high priority, in the allocation of capital, to industrial development. They have no great highway nets like ours; movement of goods is by train, movement of people is by the mass forms of train, bus, and airplane instead of by individual auto or even individual airplane, as with us. Their village-to-village roads are the dirt, mud-soggy affairs ours were twenty-five to fifty years ago.

The United States uses tremendous amounts of petroleum products for transportation of goods and people; in the U.S.S.R. the motive source is coal and electricity. Russian engineers told the American visitors that their country would never follow America's example of building a national transportation system based on individual automobile ownership. They said such a system was too wasteful; with a much smaller investment of capital, a nation could provide an entirely adequate system of mass transportation consisting of modern airplanes, railroads, buses, and subways. They argued that such a mass transportation system also reduced the need for capital expenditure for elaborate highway systems and parking facilities. Part of the Soviet scheme is to have great self-sustaining industrial centers, with workers assigned each to his job and living in the immediate vicinity of his place of work, thus reducing the transportation problem. These communities are grouped around factories and have their own school systems, restaurants, theaters, and shopping centers.



Figure 44 - Apartments under construction. Housing like this is part of the scheme of having workers live near the factories they work in. The apartment houses are made of precast concrete



Figure 45 - Completed apartments

In the Soviet culture, most city people live in apartment houses, government built and owned. Here in the United States the privately owned home is a sort of symbol of citizenry--and, of course, 50 families each living in its own home use far more energy for heating than 50 families in a centrally heated apartment house. The apartment houses are heated by central steamplants that generate the heat for a number of houses and, in some cases, generate electricity. The Russian engineers contend that multiple-unit housing is much more economical and makes better use of capital.

The Soviet Union does not, nor will it ever, use either energy or the components of it--coal, oil, gas, wood, falling water--within the same kind of pattern as we do, and we must remember this in assessing their ability to reach the energy goals they have set for themselves. The differences reflect mainly the differences in the social goals of the two systems.

SUMMARY STATEMENT

by

SECRETARY OF THE INTERIOR - STEWART L. UDALL

One method of measuring the economic power of any modern nation is by the energy it has to drive its machines. Most of this energy is ultimately used in the form of electric power, and therefore in one sense the main muscle of any country can be measured by the quantities of kilowatts it is able to generate. This explains, of course, the high priority the Soviet regime is giving to its power station construction program. During my talk with him, Chairman Khrushchev put his own conviction in these words: "Whoever has the most mechanical robots will be the richest."

Save for military and space requirements, it is plain the electrification program has one of the very highest priorities in Soviet planning. New industries, regardless of other factors affecting feasibility, cannot be established until electric power is available, and consequently power is the sine qua non of industrialization in economic planning. Those who desire insight into the thinking of the Soviet leaders should read a revealing and informative speech delivered by Chairman Khrushchev to the All-Union Conference of the Power Station Construction Industry in Moscow on November 28, 1959. (This address is remarkable, both for the fascinating glimpses it gives of Mr. Khrushchev's leadership techniques and for its clear description of the electrification plans and aspirations of the Soviet regime. It appears in Senate Document No. 71, 86th Congress.)



Beyond any question, the work of the hydro-station and high-voltage transmission line builders is one of the solid success stories of Soviet Russia. However, their success in constructing thermal power stations still lags behind United States performance.

But, to put this performance in proper perspective, one must point out that their construction-production successes are partially nullified by the substantial failure of the Soviets in giving the Soviet people an adequate share of the benefits of electrification. The U.S.S.R. lags far behind the U.S. in rural electrification, and in making electricity work to lighten the daily burdens of the people. The most reliable figures available show that about 28% of electric power in the United States goes to individual consumer uses, against only approximately 15% in the U.S.S.R. It is our conviction that the value to a society of its electrification system is best judged in the long run by the manner in which its fruits are distributed to the people themselves.

It seems likely the Soviets will come close to their target figure and put nearly ten million kilowatts of new generating capacity on the line during 1962. This will represent a striking increase over the 1961 addition of only 7.1 million kilowatts. (The comparable U.S. additions were 12.2 million kilowatts in 1961, and a projected 12 million kilowatts in 1962.) When one considers that today the over-all economic capacity of the Soviet Union is roughly one-third ours, this gain can be seen in proper perspective. (One

benchmark of comparison is that the present total installed operating capacity of the U.S. is 211 million kilowatts, against a similar Soviet capacity of 84 million kilowatts.)

On the basis of our observations, it is my opinion that the success of the U.S.S.R. electrification program can be attributed to a combination of these factors.

1) In terms of budgets and brainpower the regime has given this program a very high priority;

2) For the most part, Chairman Khrushchev has picked able engineer-administrators to head up this program and has given them wide latitude and strong support to carry out their work;

3) The Ministry has also been given authority in some areas to increase the performance of its working force by special individual incentives. One must admire, for example, the pioneering spirit of the workers at Bratsk in the Siberian taiga where the dam builders work at temperatures as low as 40 degrees below zero. However, it is highly significant--and equitable, too, by American standards--that most of them receive pay and one half or double pay, and, in addition, a substantial number are accorded loans to build and own their own homes--a rare privilege today anywhere in the Soviet Union.

4) It was also apparent that the engineers and managers in charge of power construction projects are delegated wide decision-making responsibility. (Incidentally, this may explain the superior

performance of the power construction people as compared with industrial plant management where all reports indicate tight centralized controls often restrict action and limit decision-making.)

5) The engineers and scientists who work on the research programs of the Power Station Construction Ministry appear to work easily together. There is every indication the scientific method dominates their deliberations, and that the choice of design criteria is made after careful analysis.

6) It was also obvious that the Power Station people realize that they have much to gain through a free exchange of information with engineers and technicians of other countries who are working in this field. In their hydro-dam and EHV alternating current transmission programs they have wisely rejected the secrecy obsession which dominates Soviet thinking in many areas. (Chairman Khrushchev himself, I gathered, realizes that his engineers have profited greatly from contacts with scientists and engineers of other countries--including our own. During the course of our conversation, when I made a jocular reference to the fact that I had been inspecting his installations to find out the secrets of his engineers, he laughed heartily and said, "Well, if that is the case, take off your coat and let's get down to business." We then removed our coats and continued our talk.) We were not in a position to evaluate the importance of its clearing-house work, but again it is apparent that the systematic world-wide gathering and translating of scientific data by the State Scientific

Coordinating Committee is considered a highly useful exercise by the Soviets.

7) The Power Station Construction Ministry also clearly has a special advantage in the keen interest which Chairman Khrushchev himself has taken in their work. It goes without saying that his looking-over-the-shoulder interest creates pride--and also stimulates performance.

Speaking generally, I would say that we had a very favorable personal impression of the engineers and administrators in charge of the Soviet electrification program. These second-generation Soviet leaders are engrossed in the rewarding task of building their country and developing its resources. Many of them have climbed the ladder from the bottom rung: Mr. Chuprakov, for example, worked as an electrician on the first small Soviet hydro project, and is now busy designing the largest hydro-dams in the world.

These are pragmatic men. They are builders whose success rests on adherence to the disciplines of science and a willingness to take risks to develop new technology. They are committed to the Communist ideology--but appear to be convinced that the best way to demonstrate its validity is by production and performance.

My talk with Chairman Khrushchev at Gagra, Georgia, was devoted in the main to electric power and natural resource problems and the specific things we saw during our limited stay in Russia.

At the outset we compared the geography and natural resources of our two countries. He then agreed with my statement that the economic strength of a country rests on 1) its available natural resources, 2) the skill and competence of its workers (i.e., science and education), and 3) the economic system it uses to organize its programs of development.

Mr. Khrushchev indicated that he regarded the field of electric power as much like the field of medicine. The power field, he said "Is a good one for competition ... America has great potential in this field and that is precisely why we want to compete with America." He also acknowledged that the United States is far ahead of the Soviet Union at present, but indicated that this made the competition "more interesting, because when you catch up from so far behind you have much more to be proud of." He also stated that in such a competition no one loses because it is a "competition for stockpiling wealth."

At one point our discussion also turned to the space race and Premier Khrushchev discussed it in relationship to the electric power programs of our two countries. He said, "Outer space is just an area which brings us greater scientific knowledge--materially, it gains you nothing. We don't think we should necessarily be first on the moon, but we shouldn't get there too late, either. The main thing now is electric power and industry. Space gives you prestige, to be sure, but it isn't the primary thing."

Chairman Khrushchev also indicated a keen awareness of the importance of the productivity of labor. He conceded that today America is "far ahead" in the productivity of our work force, but he indicated he had no doubt the Soviets would overtake us. He summed up his convictions with these words: "The gap between us is narrowing every year. You have almost filled your goblets, and now are faced with a crisis of overproduction, where we have no such limitations due to the advantages of the Socialist system." He also acknowledged that the gap between our two economic systems was "sharpest" in agriculture. However, he expressed the opinion that Soviet agriculture was gaining and that cheap electric power would help increase the productivity of farm labor. Speaking of large tractors and new farm equipment, he stated: "We'll do our work cheaper than America."

On the basis of insights gained during and subsequent to our trip, I should also like to make the following general observations:

a. In terms of the projects which we examined, it appears that in most ways the Russian engineers and builders compare favorably with those of the United States and other advanced countries. If one were to single out particular accomplishments for praise, mention would certainly be due the pace of their construction schedules and their apparent ability to absorb lessons on each project that save time and money on the next.

b. Chairman Khrushchev himself is constantly demanding greater speed and efficiency, and this serves to encourage the taking of short-cuts and the use of promising engineering techniques. (When I expressed the opinion that he seemed to have a better nose for engineering talent than Stalin, he replied: "No, they are mostly the same men. We just give them more initiative.") Such initiative was that demonstrated to us very forcefully by Deputy Minister (now Minister) Neporozhny. At the Bratsk project, concrete is mixed at a batch plant 1-1/2 miles from the dam site and delivered by dump truck to hoist-buckets which are then lowered to the dam itself. By 1962 standards, this is admittedly a rather crude and costly delivery system. Minister Neporozhny is a concrete specialist, and he informed us that he has designed a far more efficient concrete system which will be used for the huge Krasnoyarsk Dam on the Yenisey River. During his visit to the United States last May, he spent several hours studying the automated electronic batch plant operated by Merritt-Chapman and Scott Company at the Glen Canyon project in northern Arizona--a modern plant that is largely automated, and operated electronically. Before we left Moscow, Mr. Neporozhny presented me with a large book containing his designs and plans for what he called a "fully automated, continuous-pouring concrete delivery system." If

his plan functions well at Krasnoyarsk, it will exemplify the type of initiative which has contributed much to the success of the Soviet power station construction program.

c. During the past three years, the rate of expansion of Soviet generating capacity has been high, and it is now a conservative assumption that the Soviets will reach their goal and have at least 113 million kilowatts of installed generating capacity on the line by 1965. The statistics show that while the annual increase in installed capacity in the United States during the past four years has dropped from 13.7 millions of kilowatts to less than 12, during the same period the U.S.S.R. has increased from 5.7 to nearly 10. While it is recognized that the U.S.S.R. is at a lower stage in its development, it is achieving, nevertheless, an impressive and sustained upward trend. If a conservative approach is used, it would hardly be safe to assume that their pattern of increase will necessarily level off as the total generating capacity grows. Of even greater significance for the long haul, is the related goal of achieving substantial reductions in the cost of electric power. We were unable to check Soviet cost figures with confidence (due in part to the fact that their "bookkeeping" system is so different from our own) but this is unquestionably a major objective of their program.

d. It is also obvious that the Soviet planners realize that their engineering achievements have prestige value in



the world market place. The "dream project" of Soviet engineers is the building of a dam in permafrost terrain at the mouth of the Lena River at a latitude north of Point Barrow, Alaska. This proposed dam would have an installed capacity of at least 20 million kilowatts--ten times the capacity of our largest, Grand Coulee. This dam is not scheduled for construction for fifteen or twenty years--indeed, it may never be built--but the point is that Soviet engineers and designers have it very much on their minds and are fully aware of the prestige which would come to them, and to their country, if an engineering work of this magnitude were actually built.

Their progress in the production and transmission of power should disturb the complacent here--just as our progress in distributing the electric power we produce so that it serves the needs of all people must be a source of distress to the leaders of the Soviet regime.

One of Russia's great advantages is its integrated system of power transmission. Through this system, an effective arrangement of interties will make possible a much higher percentage of firm power than we enjoy in the United States with equivalent generating stations operating singly. Our system is fragmented, but we can be heartened by action and planning that will result in greater integration for the United States. This trend must be accelerated if we are not to lose a substantial advantage we would otherwise possess due to the over-all size and superiority of our generating system.

If we are bold and energetic we can outperform any other system in terms of practical achievement--and share the benefits of such performance more widely among our people as well.

In the long run our mixed system of public and private power will stimulate the right rate of growth if we strive constantly to eliminate waste and to avoid destructive disputes. President Kennedy expressed his view on our energy problems very clearly in South Dakota last August when he said:

"We cannot permit railroads to prevent coal slurry pipelines from conveying the resources of our mines. We cannot permit the mining industry to say there shall be no nuclear energy because it may affect them adversely. We cannot permit, as a country, public and private power interests to veto each other's projects, or one region to say another region shall not develop. If we do that, we shall stand still and forget the lesson history has taught us."

One of the remarkable achievements of our own country, since the low point of the great depression, has been our pioneering work in science and technology--and above all our achievement in making the fruits of science and technology available to all of our people.

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On behalf of the members of the U.S. delegation, I should like to express our warm thanks to the two Soviet officials whose cooperation

and friendly spirit did so much to make our trip profitable and informative. I refer, of course, to the First Deputy Minister of Power Station Construction Pjotr S. Neporozhny, our Moscow host; and N. M. Chuprakov, Chief Engineer of the Design Department of the Ministry of Power Station Construction, who was our guide and escort on our trip to Siberia and along the Volga. It was largely through their efforts that we had a thorough look at the installations we visited, and obtained much of the data which was of primary interest to us.

On a personal level, I also should like to express appreciation to Chairman Khrushchev for a candid discussion of electric power and resource development programs of our respective countries, and for presenting me a 45-minute film which explains the goals and progress of the Soviet electric power program.

During my visit with Chairman Khrushchev at Gagra, Georgia, on September 6th, the Minister of Power Station Construction, Ignatiy T. Novikov, was my host, and I also owe him special thanks. In the course of our visit we had a wide-ranging discussion of mutual problems, including spirited arguments about our respective economic systems. Novikov is a Ukrainian engineer who worked his way up through the ranks, and was selected by Mr. Khrushchev in 1957 to succeed former Premier Georgi Malenkov as head of the electric power development program. He is a tough-minded, and has all the characteristics of an able, hard-driving administrator. He is proud of the achievements of his ministry. His builders are

constructing the largest dams ever built and the zest and competitive spirit he brings to his work is reminiscent of Henry J. Kaiser in his prime.

Minister Novikov participated in my discussion with Chairman Khrushchev. It was obvious that he is highly regarded by the Premier, and I was hardly surprised when Novikov was promoted to Deputy Premier on November 25 and given control of a new ministry which will supervise all capital construction in the Soviet Union.

Finally, I wish to thank the members of the United States delegation for their insights and for their untiring efforts in making our mission a success.